Accomplishments in Tobacco Research in North Carolina

March 1, 1987 - February 29, 1988

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ACCOMPLISHMENTS IN TOBACCO RESEARCH

IN NORTH CAROLINA

March 1, 1987 - February 29, 1988

Prepared by the Tobacco Staff at
North Carolina State University,
Raleigh, North Carolina

This information presented in the annual report is NOT FOR PUBLICATION but represents preliminary findings which may later appear in published form. We trust that you will find this information of interest and value.

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PREFACE

The North Carolina Agricultural Research Service supported 63 projects on various aspects of tobacco research in 1987. Forty-nine faculty members from 8 of the 20 departments in the College of Agriculture and Life Sciences devoted 19.8 scientist years (full-time equivalence) to tobacco research. Total expenditures during 1987 were approximately $5.67 million, an increase of about $0.36 million over 1986. It is of interest to note that 19 years ago (1968), 34 faculty from nine departments devoted 24.6 scientist years to tobacco research with expenditures of approximately $1.4 million. Total support years for tobacco research in 1987 (includes scientists, technicians, post-doctorals, and clerical) were 97.9, up slightly from 97.8 in 1986.

The USDA-ARS Oxford Tobacco Research Laboratory at Oxford, North Carolina is an essential component of our total tobacco research program. The above data do not include federal dollars expended in support of this laboratory.

Supplemental support provided by growers, warehousemen, leaf exporters and manufacturers of tobacco products through the North Carolina Tobacco Foundation continues to stimulate project leaders to strive for a "margin of excellence" that might not be attainable with support only from appropriated funds. Tobacco Foundation allocations plus industry grants for research were approximately $755,000 with the majority received from the Foundation. Mr. H. Graham Knott, Jr., Kinston, North Carolina was elected in October to serve as President for the 1987-88 term.

Funds received for special activities or projects have greatly enhanced various aspects of the overall tobacco research program. Of particular importance has been support provided for the following: three post-doctoral fellowships on a continuing basis; an undergraduate research apprenticeship program, which enables up to eight outstanding undergraduate students to receive a research experience working with selected faculty; the graduate research assistantship supplement fund, which permits N. C. State University to attract the more promising students into graduate research programs on tobacco; the research equipment fund for assisting scientists in the purchase of needed scientific equipment; and expanded research effort in areas of varietal development, disease control, leaf quality and mechanization.

Since our last report, several of our tobacco faculty have retired or moved to another location. Dr. G. Richard Gwynn, Professor of Crop Science and Research Agronomist with the USDA Tobacco Research Laboratory, retired after 30 years of government service. Also, Mr. Rupert W. Watkins, Professor of Biological and Agricultural Engineering retired after completing almost 30 years in research and extension. We wish them our very best in their retirements and commend them for their leadership and research accomplishments, which have greatly benefitted the U. S. Tobacco industry. Mr. Steven A. Hatchett, Assistant Professor of Economics and Business, has relocated to California after working several years here in the area of production economics.

Dr. Harvey W. Spurr, Jr. was appointed in April, 1987 as Director and Research Leader of the USDA Tobacco Research Laboratory at Oxford, North Carolina. We congratulate Dr. Spurr for this appointment and wish him well in

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this new position. Also, we welcome Dr. Bruce A. Babcock, Assistant Professor of Economics and Business, who accepted an extension/research position in the area of tobacco policy and marketing.

Again, we are pleased with the overall accomplishments in tobacco research in North Carolina during 1987, with the faculty commitment, and with the strength and broad scope of activities underway. New challenges and opportunities await us in 1988 as we seek solutions to problems of importance to this great industry.

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Title: NC 03995 Biochemical Control of Senescence in Tobacco Leaves

Project Leader: Edward C. Sisler

I. Summary of Research:

This project has the following objective:

To study the ripening processes in tobacco leaves and to develop means of controlling these processes.

Interaction of Dicamba and Ethylene on Tobacco Leaves

Dicamba (3,6-dichloro-o-anisic acid), when applied to tobacco leaves in the field, causes a "yellowing" similar to that caused by ethylene or ethylene-releasing agents. When dicamba was applied to greenhouse-grown tobacco leaves, ethylene production was increased 1.5x by 0.2mM and 5x by 1mM dicamba. Treatment with either 1mM Co ion or 1mM Co ion plus 1mM dicamba reduced ethylene production below control levels. Dicamba at concentrations of 0.1µg to 0.1mM caused an increase in chlorophyllase, an enzyme induced by ethylene.

2,5-Norbornadiene (2000µl/l) added to dicamba-treated leaves reduced the amount of chlorophyllase induced by dicamba, but did not completely eliminate the induction. Dicamba at 0.1µM to 0.1mM caused an increase in the degradation of chlorophyll. Co ion at 1mM and Ag ion (10mg/l) reduced the amount of chlorophyll, which disappeared at 0.1mM dicamba over a 7-day period, but as the concentration of dicamba was increased to 1mM, the effects of both Co ion and Ag ion were greatly reduced.

It appears that part of the dicamba-induced yellowing effect is due to dicamba-induced ethylene and part is not an ethylene effect.

IIB. Special Student: Leigh Ann Young, R. J. Reynolds Research Apprentice.

III. Postdoctoral Fellows: None

IV. Publications:

Sisler, E. C., S. F. Yang. 1987. Ethylene. In "Models in Plant Physiology and Biochemistry" (Newman, D. W., and K. G. Wilson, eds), pp. 99-102. CRC Press, Inc., Boca Raton.

Sisler, E. C. 1987. Purification of the ethylene-binding component from mung bean sprouts and seeds. In "Plant Hormone Receptors," NATO Advanced Study Institute Series Vol. H10 (Klämbt, D., ed), pp. 297-301. Springer-Verlag, Berlin, Heidelberg.

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Sisler, E. C., and C. Wood. 1987. Ethylene binding and evidence that binding in vivo and in vitro is to the physiological receptor. In "Plant Hormone Receptors," NATO Advanced Study Institute Series Vol. H10 (Klämbt, D., ed), pp. 239-248. Springer-Verlag, Berlin, Heidelberg.

Sisler, E. C. 1987. Induction of chlorophyllase in tobacco leaves by ethylene and auxin. Tobacco Sci. 31:20-22.

Sisler, E. C. 1987. Effect of ethylene, auxins and antiauxin on chlorophyllase in tobacco leaves. Plant Physiol. 80:S-160 (Abstr).

Sisler, E. C., and C. Wood. 1987. Displacement of ethylene from the binding site by various compounds. Plant Physiol. 80:S-160 (Abstr).

V. Manuscripts Accepted for Publication:

Sisler, E. C., and C. Wood. 1988. Displacement of bound ethylene by olefins in vivo and in vitro. Plant Growth Regul.

Sisler, E. C., and C. Wood. 1988. Interaction of ethylene and CO_2. Physiol. Plant.

VI. Manuscripts in Review:

Blankenship, S. M., and E. C. Sisler. Ethylene binding in apple and morning glory during ripening and senescence. J. Plant Growth Regul.

Title: NC038C
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Project Leaders

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Title: NC03801 Improved System for Transplant Production and Direct Seeding of Tobacco.

Project Leaders: S.C. Mohapatra and C.W. Suggs

I. Summary of Research

Research conducted during 1987-88 are summarized below under three categories: A) Field Research, B) Laboratory Research and C) Greenhouse research.

A. FILED RESEARCH

All investigations under this category were conducted at the Central Research Station, Clayton in permanent plantbed locations. The bed layout, seeding and undercutting equipments and methods used for this purpose have been described in earlier annual reports. Unless otherwise mentioned, the following procedure for data collection and analysis was followed for each field experiment described. Germination was counted weekly for six weeks, then skipped for two weeks, and again counted for the final two weeks before transplanting. Thus, there were eight data groups covering a ten-week period. This approach was necessary because of unexpected inclement weather, without which the experiment was expected to be completed during the first eight weeks. Each sample site measured 12" x 6.75" and constituted one of the several subreplicates within a replicate, the number of which varied between studies depending on the statistical design in use. A new set of sample sites was used each week to avoid the effect of frequent cover removal and replacement. Samples from the final plant count site were transported to the laboratory for growth parameter measurement.

The quantitative method reported in the 1987 accomplishment report was used for quick comparison of seed treatments designed to improve germination rate. Briefly, the method is as follows:

$$\text{RER (Relative Emergence Rate)} = \frac{MGP}{W}$$

where: MGP = Maximum germination percentage and is calculated as

$$\frac{M}{E}$$

E = Expected seedling number, this is 27 for the sample site measuring 12" x 6.75"

M = Maximum (average) seedling number at the sample site

W = The week of plant count in which the maximum number of seedlings was obtained

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Field experiments conducted during 1987 are summarized below under individual studies. The above interpretations will be used for various data wherever applicable.

Study #1 (Plantbed covers):

Polyethylene or other clear plastic films make popular plantbed covers. Such covers admit light but trap heat as the long-wave energy radiated from the soil surface cannot readily penetrate the plastic film. The film, being impervious to water keeps the soil, including the surface, moist.

The temperature and moisture conditions thus generated by a polyethylene film plantbed cover are conducive to seed germination and seedling growth except for the hazard that the temperature may get too high during a sunny day. Normally the temperature under a plastic cover does not get too high in February or March when ambient temperatures are likely to be low, days are relatively short and the sun's angle is low. However, in April bed temperatures under clear plastic between 115 and 120°F are possible on sunny days with ambient temperatures below 70F, Fig. 1 (solid plastic). These temperatures are high enough to kill or seriously injure many of the plants. Perforating the plastic or covering it with a black mesh shade cloth over the clear plastic did not lower the temperature. Cutting several inch long slits in the plastic every few inches opened up enough air exchange area to lower the midday temperature by 10 to 20F. Reemay resulted in about the same temperature as slit white plastic. Soil temperature in the shade (Shaded TC, thermocouple) did not get nearly as high as measurements made in the sun.

Although there were differences in the number and size of the plants produced under the various covers, there were no differences in the yield and value of crops produced from these plants.

It can be concluded that the temperature characteristics which make plastic films desirable in cold weather create problems later in the season when the ambient temperature and the angle of the sun increase. A solution to the present practice of changing to a porous air permeable cover when the weather warms up needs to be sought.

Study #2 (Effect of root and leaf removal on transplant survival, growth, yield, value and chemistry):

Transplant pulling often results in loss of root mass (including the breakage of the tap root) and injury to one or more leaves. Leaf injury/loss further increases during transplant handling and the transplanting operation itself. While short root and as little foliage as possible are desirable characteristics (to minimize possible entanglement) of transplants meant for mechanical handling and transplanting, it is generally believed that the transplant should have as much root and foliage as possible to minimize transplanting shock. Inasmuch as the pulled transplant produces new roots and leaves during post transplanting establishment and the precise role of the existing root and foliage is not known, 12 treatments involving removal of leaves and/or roots were used prior to transplanting to address this question.

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TREATMENT #	DESCRIPTION
1	Control
2	1/3 leaves stripped off bottom
3	2/3 leaves stripped off bottom
4	All leaves except apical bud stripped off
5	1/3 root prunned, bottom to top
6	2/3 root prunned, bottom to top
7	1/3 root prunned, lateral roots only
8	2/3 root prunned, lateral roots only
9	Treatments 2 + 5
10	Treatments 2 + 6
11	Treatments 3 + 5
12	Treatments 3 + 6

As shown in Fig. 2, loss of either the root mass or the foliage or both did not have detectable effect on yield, price or value. This suggests that there is considerable flexibility in transplant handling relative to root and foliage loss without serious physiological or economic consequence. The root and leaf removal treatments, however, influenced the chemistry of the cured product with respect to total sugar and alkaloid contents, but these effects were not statistically significant. These questions will be addressed to in greater details during the coming season.

Study #3 (DPI Treatment vs Pellet Drilling): Tobacco seeds procured from the Speight Seed Farms were divided into three batches. One batch was treated with the dark preincubation (DPI) treatment described in previous annual reports. The treated batch and the two untreated batches were mailed to the Royal Sluis Company, Salinas, CA, where one of the two untreated batches was given a proprietary treatment (RS-Treatment) and all the three seed batches were pelletized. As in previous years, both seed treatments improved germination rate over that of the control, but the DPI treatment gave better germination uniformity than the Royal Sluis-treatment.

Study #4 (DPI Treatment vs Fluid Drilling): This study was similar to the above study except that seeding was done through gel drilling (i.e., fluid drilling) of naked seeds. Therefore, no RS-treatment was included. The DPI treated seeds had a much higher RER (data not shown) value than the untreated seeds. Comparison of data for Study #1 and #2 show that the untreated naked seed had a higher RER value than that of the untreated coated seed. It is not known at this time if the difference was due to adverse effect of the coating material/method or to the promotive effect of the fluid drilling materials/method.

Study #5 (Germination Advancement): In this study, seeds were pregerminated for 48 to 72 hours followed by gel seeding of the treated seeds. The 24-hour treatment was dropped from this year because the previous year's data showed that there was no significant difference between the control and this treatment. The timing of germination advancement was adjusted to permit seeding of all seed lots in the same day. This study had two major objectives: a) to allow the seeds to complete the rate limiting steps under favorable

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conditions in the lab and b) to permit late seeding when inclement weather does not permit seeding on schedule for conventional plantbed operations. As expected, RGR values increased with advancement in germination prior to seeding. Also, as expected, the control (untreated) seeds performed about the same as in Study #2 and #3.

B. LABORATORY RESEARCH

Various laboratory investigations conducted during 1987 are summarized below under two major subheadings: A) Seed physiology and metabolism, and B) Biotechnology and bioengineering.

B.1.Seed Physiology and Metabolism:

Study 1. (Development of a starch extraction and estimation method): Starch is an important energy source during seed germination and is also the chief energy storage system during photosynthesis. Therefore starch metabolism plays a key role in seed germination and seedling establishment. Because of the numerous techniques available for the extraction and estimation of starch, it needs to be determined if a given technique is tissue and species specific or not. Therefore, some of the frequently used methods were compared during 1987. Results show that none of these methods was effective as such for complete extraction and quantitation of leaf or seed starch. However, combination of the salient features of several methods was found to extract most of the starch content quantitatively and reproducibly. While this study is in progress, the following steps are giving best results at present.

1. Extract tissue in hot 80% ethanol to eliminate soluble sugars
2. Autoclave the residue from above for 15 min and filter the hot slurry under suction
3. Add perchloric acid to the supernatent from above to keep starch in solution.
4. Repeat steps 2 & 3 and combine the supernatents.
5. Estimate starch at 600 nm following reaction with Iodine-potassium iodide solution; use soluble starch as standard.

Study 2. Physiology of Autotrophic Transition: Cotyledon photosynthesis is crucial during seedling establishment, which consists of root growth and foliage leaf development and continues to be so until sufficient photosynthetic area becomes available through the newly formed foliage leaves. Environmental stress (including nutrient deficiency in the plantbed) during seedling establishment usually results in the yellowing of the cotyledons and their death in more extreme cases. Cotyledonary inefficiency or loss should become less consequential with gradual increase in the photosynthetic area. It is therefore important to establish the temporal significance of cotyledonary photosynthesis with respect to seedling establishment and growth. This was done in 1987, as in 1986, by selectively manipulating the photosynthetic area

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through the removal of one or more cotyledons or foliage leaves. Results obtained were essentially similar to those obtained during 1986. The fact that cotyledons had higher fresh weight and dry weight per unit area than the foliage leaves suggests that cotyledonary photosynthesis plays a major role in seedling survival during the appearance of the first four foliage leaves. This conclusion was supported by data on respiration, photosynthesis, and dry matter accumulation.

B.2. Biotechnology and Bioengineering:

Study 1. Molecular Biology of Thermal Stress: Research in previous years has led to the identification of tobacco cultivars with unusual tolerance for high germination temperature. As shown in Fig. 4, the control variety (Speight G-28) germinates at temperatures between 23-26 C whereas the thermotolerant variety (Speight G-140) germinates at temperatures between 32-35 C. Attempts were initiated during 1987 to identify the genes responsible for such unusual thermotolerance. Since gel electrophoresis of proteins is the first necessary step in this direction, SDS-PAGE of the protein extract from ungerminated seeds has been completed to date. Similarities between protein band patterns of both cultivars suggest that the seeds probably synthesize new classes of protein during the germination process to facilitate thermotolerance. This aspect will be further investigated during the coming years.

Study 2. Tissue and Embryo Culture: An important question pertaining to thermotolerance discussed above is whether this phenomenon is limited to the seed germination phase only, thus representing a narrow developmental window, or it exists throughout the life cycle. If the latter is true, the Speight G-140 cultivar might offer an opportunity for germplasm advancement through genetic engineering. Even if the thermal response is limited to the germination phase only, it should serve as a model for basic investigations on the molecular biology of stress physiology and regulation of the associated genes. The main experimental task in this regard is to develop a system through which the above question can be tested. The most direct approach for this is to grow plants from seed to maturity at selected temperature(s). But this approach will require additional space and manpower. Tissue culture technique is a preferred alternative because it requires less space and labor and, more importantly, requires much less stringent cultural management. This approach is based on the hypothesis that a germplasm having thermotolerance should be able to regenerate at relatively higher temperatures. But before this can be done, tissue culture conditions are being standardized at present. Among the variables tested to date are media composition and age, leaf area and age, incubation temperature(s), and effects of sterilization techniques.

C. GREENHOUSE PRODUCTION OF TOBACCO TRANSPLANTS

Study #1 (Evaluation of seeding methods for germination): Currently two types of green house systems are in use in North Carolina. One version consists of the conventional tray system with overhead sprinklers and forced air heating whereas the newer system consists of floating trays with heating being accomplished through water-bed heaters placed strategically under the water bed. While our ongoing research deals with both systems, current emphasis is on the latter. Accordingly, a float system built in this department was

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described in the 1986 report. This system was used in 1987 to conduct experiments on seeding methods. Significance of this study lies in the fact that the float system in use at present involves transplanting of small seedlings called "plugs" to larger trays. The transplants are then grown to the normal size in the floating trays and transplanted to the field at the appropriate time. A major economic gain can be made if seeds are grown directly to transplants with the ommission of plug transplanting. Success in this venture will depend first on a suitable seeding method that would assure maximum germination percentage. This should be accomplished preferrably with the naked seed in order to enable the farmer to avoid cost, uncertainties, and inconvenience associated with pelleted seeds. On the other hand, singulation of naked tobacco seeds is a formidable task. Since cryopreservation of many biological systems has become possible, it was envisioned that seeds encapsulated within ice crystals will facilitate singulation while at the same time supplying the initial moisture needed for seed germination. Therefore, this method along with several other methods listed below were compared in 1987.

TREATMENT #	DESCRIPTION
1.	Seed placement on dry media followed by floating to saturate the media with water through absorption from the float-tray.
2.	Seed placement on dry media followed by floating and watering through overhead sprinkler. Thus, media were wetted before water was absorbed from the float tray to the seed level.
3.	Placement of ice cubes (1 x 0.5 cm) under the media surface followed by floating. When ice melted the seed was left about 0.5 cm below the media surface.
4.	Saturation of media through soaking of water from the float tray followed by seed placement on the surface of the wet media.
5.	Placement of ice cubes on the surface of the dry media followed by floating. The ice had melted to release the seed on the surface of the media by the time water was absorbed to the top of the media.

Although data in Fig. 3 can be evaluated with respect to both germination percentage and rate, the former is emphasized here because germination percentage is of greater interest than rate under the greenhouse production system. The five seeding methods ranked in this order relative to germination percentage: 4 > 1 = 5 > 2 > 3. Although seeding methods two and three were distinctly different from each other, their inhibition of germination percentage seem to have caused similar effects in that the seeds probably got embedded under the media surface following overhead spraying (method 2) and melting of the embedded ice. Ice per se, did not seem to have any adverse effect because method five gave greater than 90% final germination. It thus appears that ice-encapsulated seed can be used for the purpose of singulation

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provided that the ice can be prevented from melting during the process of melting. However, nearly 100% germination was obtained when the seed was placed on the surface of the prewetted media.

Study #2 (Field testing of transplants grown in the float system): These transplants were obtained from a commercial grower in Kinston, NC and were planted in field rows along with conventional transplants. Two sizes, Large and Medium, of float transplants were compared with mixed sizes of conventional transplants. As shown in Fig. 4, the yield and sugar content of the crop grown from transplants was slightly higher than those of the crop grown from medium-float and conventional transplants. Accordingly, the value of the former was also slightly higher than the latter two. But these differences between the three transplant types were not statistically significant. Although the general trend was same as above, the price of the crop grown from the float transplants (both medium and large) was significantly higher than that of the crop grown from conventional transplants. This is indicative of good curability and marketability of the crop grown from float-transplants. Surprisingly, however, the alkaloid content (i.e., perhaps nicotine content) followed exactly an opposite trend than that described above. Thus, alkaloid content of the crop grown from the float-transplants was decidedly lower than that of the crop grown from conventional transplants. Further verification of these results is needed before any conclusion can be made on the significance of these results.

II. GRADUATE STUDENTS: Barba M. Koroma

III. POSTDOCTORAL FELLOW: None

IV. PUBLICATIONS:

1. Mohapatra, S.C., and H.E. Pattee. Correlative light and scanning electron microscopy of thin sections and isolated cells. In "Correlative Microscopy in Biology", (M.A. Hayat, Ed.), Academic Press, p.409-422.

2. Mohapatra, S.C., Arcila, J., W.H. Johnson, and L.A. Nelson. Induction of tobacco seed germination synchrony through dark preincubation treatment. Agron. J. 79: 468-472.

3. Suggs, C.W., S.C. Mohapatra, and H.B. Peel. Solid state controlled thermogradient incubator. Trans. ASAE. 30: 1149-1152.

4. Suggs, C.W., and S.C. Mohapatra. Tobacco transplants. 1. Effect of plant size on yield, value, chemistry and growth. Tob. Sci. 31: 104-108.

5. Suggs, C.W., and S.C. Mohapatra. Tobacco Transplants. 2. Effect of bareroot and intact seedlings on yield, value, chemistry and growth. 32: 1-6.

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V. MANUSCRIPTS ACCEPTED FOR PUBLICATION:

1. Mohanty, B., and S.C. Mohapatra. Effect sample preparation methods on tobacco foliar enzymes. Tob. Sci. 32: (in press).
2. Suggs, C.W., S.C. Mohapatra, and W.H. Johnson. Tobacco Transplants. 3. Effect of clipping and undercutting on yield, value, chemistry, and growth. Tob. Sci. 32:(In Press).

VI. MANUSCRIPTS IN REVIEW:

1. Suggs, C.W., and S.C. Mohapatra. Dry matter loss during tobacco leaf curing. (submitted to Tob. Sci.).

2. Mohapatra, S.C., and C.W. Suggs. Varietal differences in tobacco seed response to germination temperature. (submitted to Tob. Sci.).

3. Mohapatra, S.C., W.H. Johnson, C.W. Suggs, and L.A. Nelson. Tobacco transplants. 4. Equipments and methods for mechanization of plantbed operations (under campus review).

VII. PAPERS PRESENTED AT PROFESSIONAL MEETINGS

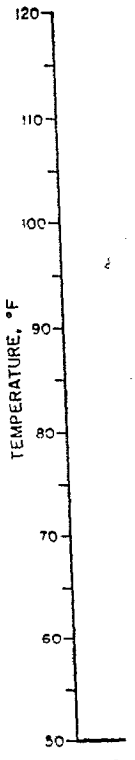
1. Mohapatra, S.C. Comparison of methods for starch extraction and estimation. Annual Meeting, Amer. Soc. Plant Physiol., St. Louis, MO, July 19-23, 1987. Abstract #855.

2. Mohanty, B., and S.C. Mohapatra. Biophysical and biochemical parameters of tobacco quality. Tob. Chem. Res. Conf., Greensboro, NC, Oct. 5-7, 1987. Abstract #64.

VIII. GRADUATE STUDENT THESES COMPLETED: NONE

IX. ACKNOWLEDGEMENTS:

Research on field experiments and greenhouse production was funded by Philip Morris USA. Technical assistance was provided by Hilton Peel, Timothy Seaboch, Tim Woody, Don Eddington, Stanley Leary, and Valsa Samuels. Secretarial assistance was provided by Brenda Mason and Ann Griffin.



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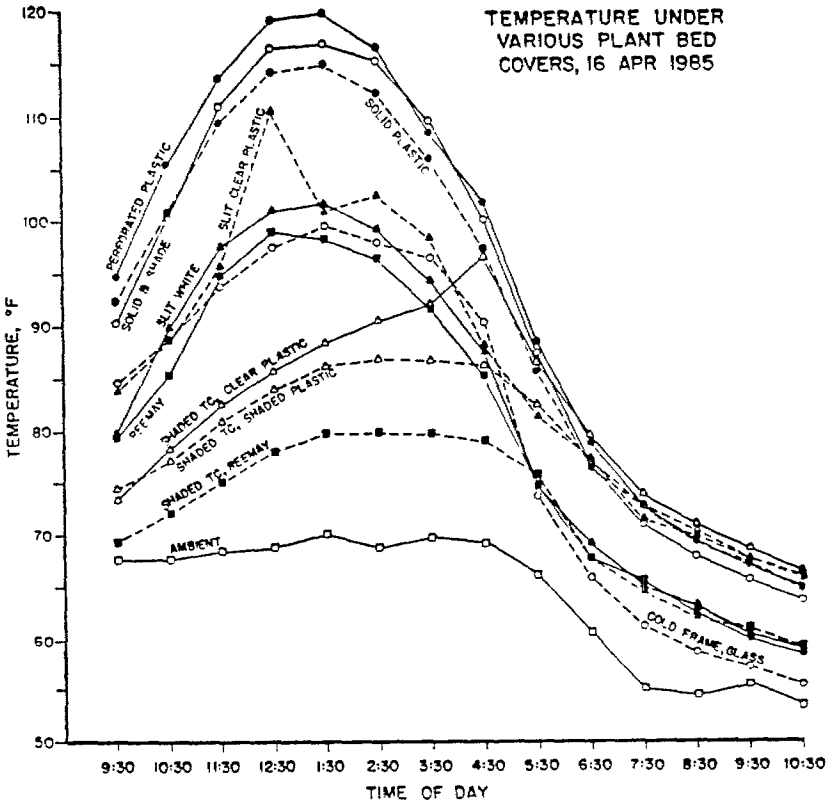

Figure 1. Typical temperatures under various plantbed covers on a warm sunny day in mid-April.

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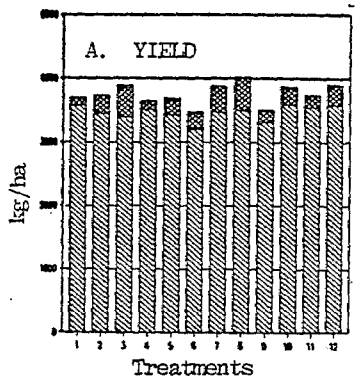

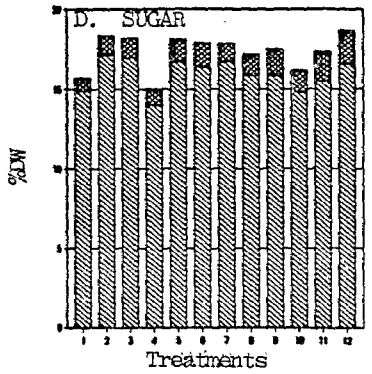

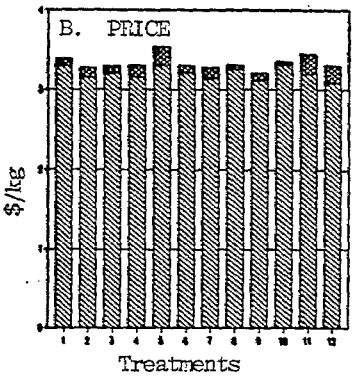

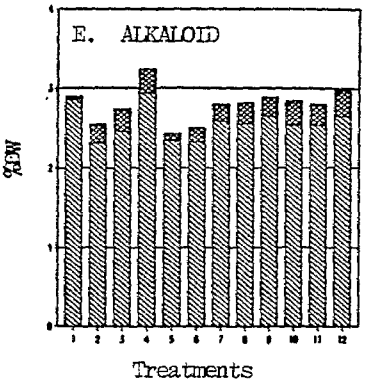

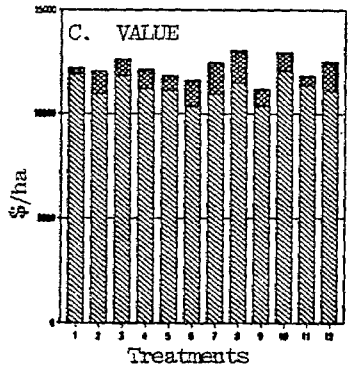

FIG. 2. Effect of root and/or leaf prunning on yield (A), price (B), value (C), and chemistry (D,E).

Treatments:
1 - control
2 - 4: 1/3, 2/3, 3/3 leaves stripped, respectively
5 - 6: 1/3 & 2/3 root prunned, bottom to top
7 - 8: 1/3 & 2/3 root prunned, lateral roots only
9 - 12: combinations of treatments 2 & 5, 2 & 6, 3 & 5, 3 & 6, respectively

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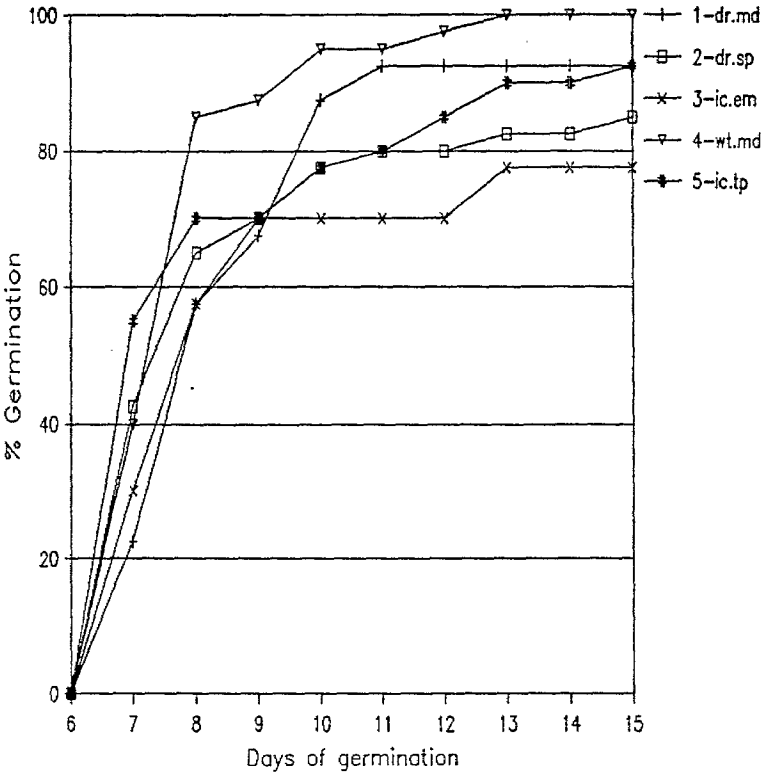

FIG. 3. Effect of seeding methods on germination rate and percentage in the float system.

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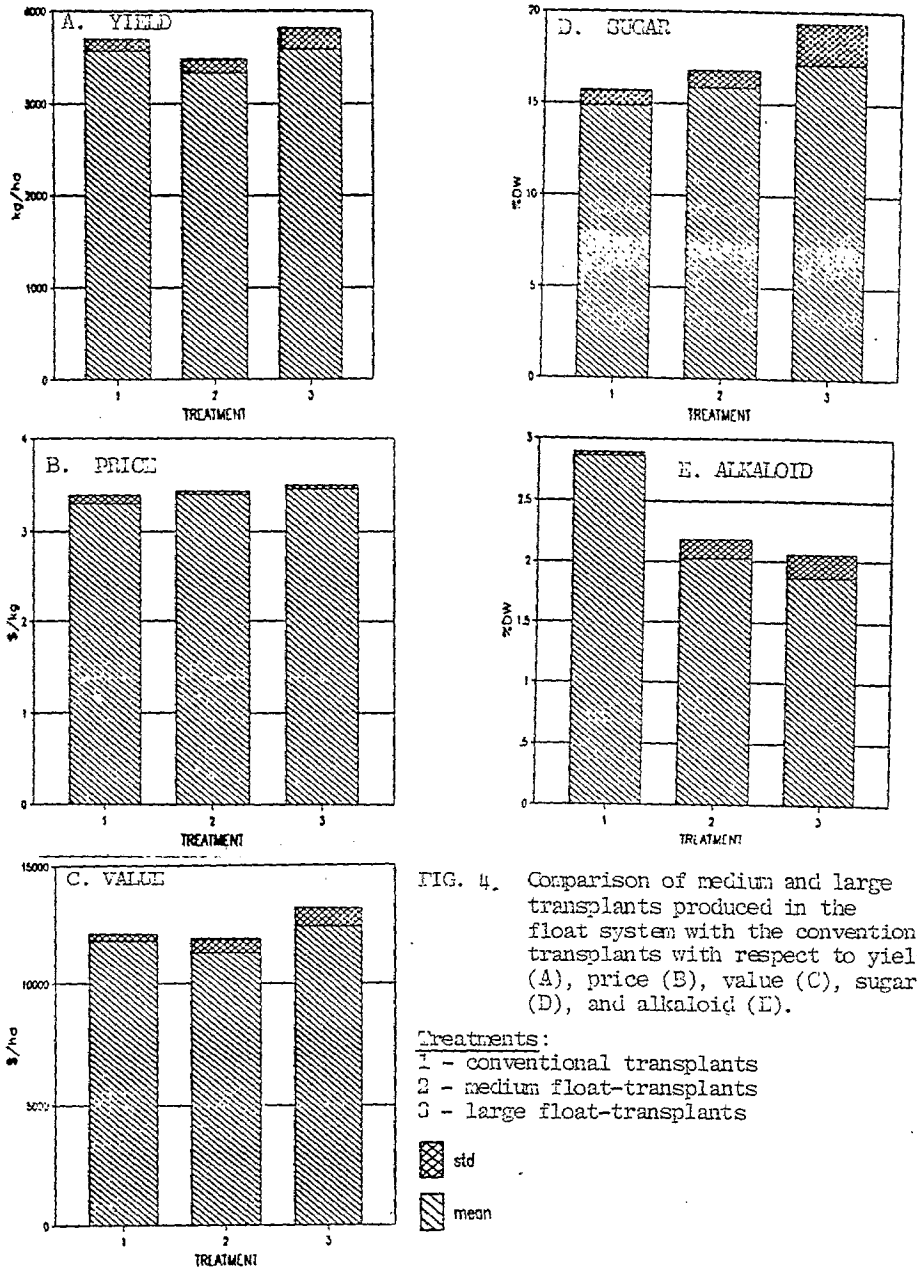

FIG. 4. Comparison of medium and large transplants produced in the float system with the conventional transplants with respect to yield (A), price (B), value (C), sugar (D), and alkaloid (E).

Treatments:
1 - conventional transplants
2 - medium float-transplants
3 - large float-transplants

Title: A

Project 1

1. Summa

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Title: NC 03804 Mechanization of Tobacco Production

Project Leader(s): C.W. Suggs and C.F. Abrams, Jr.

I. Summary of Research:

A. Development of a Harvester Mounted Spreader to Distribute Leaves into the Curing Container.

A significant amount of labor can be saved by mechanically loading the leaves into the curing container on the harvester during the priming operation. This eliminates the manual transfer of leaves from the storage bin (trailer) to the curing container and reduces the harvest crew by at least two people.

However, if mechanical loading is to be successful, the leaves must be uniformly distributed to all parts of the container. Otherwise, curing air will tend to bypass the more heavily packed areas causing poor curing, extending drying schedules and, in extreme cases, loss of part of the crop.

Although there has been some commercial development of mechanical leaf spreaders the results have not been widely accepted. In one case the spreader was compatible only with special barns. In the other case the development was not completed and the spreader was not offered for sale. For this reason the project designed, constructed and tested a harvester mounted spreader in order to characterize the problem, evaluate some possible solutions and provide design information to the industry.

The project spreader uses a short box-like tube between the conveyors and the curing container. It is oscillated in the front-to-rear direction by a hydraulic cylinder to spread the leaves over the length of the curing container. Leaves are also distributed in the transverse direction by oscillating leaf deflectors mounted inside the box-tube between the conveyors and curing containers, Fig. 1.

To measure distribution accuracy the harvester was run in the field with the spreader operating until a layer of leaves about 9 in deep, accumulated in the curing container. This leaf layer was then cut into a 4 row x 4 column grid containing 16 samples, Fig. 2. Comparison of sample weights showed a maximum deviation from the mean of around 14.5% for vertical columns of leaf.

While the spreading uniformity achieved is not as good as desired, it may be as good as hand spreading, especially when done by a person riding the machine. Test results point out deficiencies in spreader design which will be addressed before next season.

B. Effects of Schedule, Number and Type of Harvest on Tobacco Yield and Value.

Observations made over the last several years relating to ripening rates for various stalk positions suggested that a large number of the upper leaves could be harvested in one large last pass through the field. The simplicity and economy of a tractor-mounted machine for removing these last leaves was an incentive for quantifying the effects of harvest schedule on crop yield and

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value.

It was also observed that stalk cut plants with 10 to 14 leaves still attached often cured well in a bulk barn. A harvest system for this approach would involve only a field machine to cut and elevate the stalks into the curing box plus a stationary machine to strip leaves off the cured stalks.

The treatments investigated included an optimally harvested check consisting of four approximately equal primings, a four-priming sequence like the check except that the leaves were removed one-week before optimum ripeness, and a series of plots in which the first priming (1/4 stalk) was removed at various stages of ripeness and the remaining 3/4 stalk was harvested by priming or stalk cutting in a single pass two to eight weeks later.

1986 Results

Many of the treatments yielded more and had higher value than the optimally harvested check, Table 1. However, none of the treatments was signficantly higher in value than the check. There is a wide variation in the schedules which produced values higher than the check, ranging from one week green to three weeks over ripe followed usually by a two week delay before harvesting the remaining 3/4 of the stalk. Of the six highest value treatments three involved harvest of the upper 3/4 of leaves by stalk cutting. Generally, the green harvested treatments had high weight yields of lower price leaf. The range of treatments involved a wide range of ripeness and delays between removal of the lower 1/4 of the leaves and harvest of the upper 3/4. Many of the extremes had yields and values less than the check and are not included in Table 1.

1987 Results

The optimally harvested four priming check was exceeded in yield and value by many of the treatments, Table 2. As in 1986, treatments in which the lugs were removed one or two weeks pre-optimally followed by a two to 8 week delay before removal of the remaining 3/4 of the leaves often resulted in higher yield and value than the check plots. As in 1986 most of the plots yielding less than the check are not listed in the table. Although there were 12 treatments with higher values than the check none of the differences were significant.

This two years of work indicates that yields and values at least as good as from four optimum primings can be realized from a wide range of harvest schedules and techniques. This tolerance of the tobacco plant has important implication with respect to harvester design and curing barn utilization.

C. Self-Feeding Transplanter:

The project's effort and dedication toward the development of a self-feeding transplanter for tobacco was continued during the 1987 transplanting season. Several hardware developments made during the year are described below.

Table 1

Trt
POPT + 4
P1G 4 x 1
P10R + P2
P30R + P2
POPT + P2
P30R + SC2
P10R + SC2
P10R + SC4
P1G + P4
P2G + P4
POPT 3 x 1,
P20R + P2
P2G + P6
POPT 2 x 1/
P2G + SC 2
POPT-P4
LSD .05

Table 2. Ef
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Trt	P OR
POPT 4 x 1/4,	
P1G 4 x 1/4,	
P2G + P8	
POPT + SC2	
P1G + P4	
POPT + SC6	
P10R + P6	
P10R + SC4	
POPT + P4	
P30R + SC2	
P2G + SC8	
P2G + SC6	
P2G + P6	
WSC + 20R	
LSD .05	

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Table 1. Effects of Harvest Schedule and Number of Harvests on Yield, Value and Price, 1986.

P = Prime, G = Green, OR = Overripe, OPT = Optiumum,
SC = Stalk Cut Numbers are Weeks or Number of and Priming Size.
For P1OR + P2 the Lugs were Primed One Week Green and the Remaining Leaves Were Removed by Priming 2 Weeks Later.
For POPT 3 x 1/4 + 1/4 SC the Lower 3 Primings were Harvested Optimally and the Final 1/4 of the Leaves were Stalk Cut.

Trt	Kg/ha	$/ha	$/Kg
POPT + 4 x 1/4, Opt. Check	2930	10,594	3.61
P1G 4 x 1/4, Green Check	3273	11,719	3.58
P1OR + P2	3369	13,092	3.89
P3OR + P2	3201	12,305	3.85
POPT + P2	3303	12,097	3.66
P3OR + SC2	3079	12,053	3.91
P1OR + SC2	3352	11,643	3.52
P1OR + SC4	2976	11,638	3.92
P1G + P4	3108	11,608	3.73
P2G + P4	3608	11,396	3.14
POPT 3 x 1/4 + 1/4 SC	3100	11,391	3.67
P2OR + P2	2977	11,365	3.83
P2G + P6	3074	11,330	3.69
POPT 2 x 1/4 + 2/4 SC	3218	11,280	3.51
P2G + SC 2	3360	10,844	3.21
POPT-P4	2930	10,805	3.69
LSD .05	718	2,753	0.34

Table 2. Effects of Harvest Schedule and Number of Harvest on Yield, Value and Price, 1987.

P = Primed, SC = Stalk Cut, WSC = Whole Stalk Cut, G = Green,
OR = Overripe, OPT = Optimum

Trt	Kg/ha	$/ha	$/Kg
POPT 4 x 1/4, Opt. Check	3015	10,627	3.52
P1G 4 x 1/4, Green Check	2860	9,917	3.47
P2G + P8	3446	11,937	3.46
POPT + SC2	3363	11,756	3.50
P1G + P4	3974	11,672	2.89
POPT + SC6	3362	11,647	3.46
P1OR + P6	3190	11,541	3.61
P1OR + SC4	3240	11,306	3.49
POPT + P4	3149	11,290	3.58
P3OR + SC2	3346	11,273	3.37
P2G + SC8	3277	11,173	3.40
P2G + SC6	3422	10,951	3.23
P2G + P6	3103	10,915	3.52
WSC + 2OR	3247	10,844	3.36
LSD .05	766	2,595	.18

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A spiked feed wheel was developed to replace the foam rubber feed wheels on one of the machines. This was done to provide a better feeding action for the relative short thick cells used for tobacco plants. Also, the spikes perforated the paper cells in about three to six places on each side. Although no positive evaluation has yet been made, it is expected that roots will grow out into the soil through the perforations and allow the plants to start growing sooner after transplanting.

The transplanter for bare root transplants (see 1986 report) was modified to improve reliability and speed of operation. The electrically operated valve was replaced by two electrically operated clutches driven by constant running hydraulic motors. The clutches controlling the flow of mechanical power to the feed belts and the tape cutter operated faster than the hydraulic valve previously used. The sequence of events on the transplanter was electronically controlled by a programmable computer chip.

Field performance evaluation of the various types of transplants did not reveal any consistent advantages for intact root seedlings. This suggests that the incentive for transplanting automation will of necessity come from savings due to labor reduction rather than from increases in yield or value.

D. Air Flow Through Curing Containers of Mechanically Harvested Tobacco:

The importance of uniformly spreading the tobacco leaves into the curing containers and spreading equipment has been discussed in an earlier section of this report. This section addresses the relationship between loading density, drying effect and air flow through containers of tobacco.

Tobacco and other foliar crops, unlike grains and other seeds, may be compressed to produce a wide range of bulk densities. Also, these crops are often placed in the dryer at much higher moisture contents than seeds. During drying, bulk density decreases because voids develop and the overall volume occupied does not decrease appreciably.

The objective of the work reported in this section was to quantify the density-flow response of mechanically harvested and mechanically loaded curing containers of tobacco throughout the entire curing-drying process. The apparatus used to make the measurements consisted of an adjustable fan, a container of tobacco open on the top and bottom but having air-tight side walls, upper and lower plenums and a flow measuring orifice, Fig. 3.

Flow increased significantly with decreases in density, Fig. 4. Changes in density due to drying had about the same effect on flow as changes due to degree of compression of the material in the dryer. A regression of the logarithm of flow on density resulted in a straight line with an R^2 value of 0.94 to 0.99, Fig. 5. During the curing of tobacco, density decreased by a factor of 6.5 while flow for a constant pressure increased by about 5 times. In another example, a crop density decrease of 40% from an initial value of 262 kg/m^3 resulted in a flow increase of 60% for the same pressure. Slopes of pressure versus flow response for the fresh material fell between 0.5 and 1.0 as required by theory. However, slopes for the drier material toward the end of the cure decreased and sometimes fell below 0.5 This suggests that at the higher air velocities some of the material is entrained in a manner which

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decreased passage size.

The relationship between flow and density was used to normalize or adjust for density so that readings taken of several densities of material could be adjusted to a single density for comparision, Fig. 6.

E. Mechanical Harvesting and Handling Burley:

Although burley is stalk cut in the U.S., in many countries it is primed. In both cases it is air cured. There has been some interest in machine priming burley in order to reduce the harvest labor requirements. Bulk curing, a logical companion to machine priming, has also been tried with burley tobacco with mixed results. The objective of the work reported here was to investigate the possibility of machine priming and bulk curing burley tobacco.

Machine Priming:

In a 1986 test series harvesting total losses varied between 5% and 10% and averaged 7.75%. In a larger series of tests conducted in 1987 total losses averaged 8.7% and varied from zero to 22.4%. Losses from leaves which were primed from the stalk but fell to the ground before being captured by the conveyor system (leaf recovery) averaged 7.1%. Losses from leaves that the defoliators failed to remove from the stalk averaged only 1.6%.

This partition of field losses was unexpected because it was expected that the relatively steep angle of the leaves would impede the action of the defoliators. These results indicate that leaf removal in burley is as good as it is in flue cured. Leaf recovery was not as good as desired and effort will be continued to reduce these losses.

Bulk Curing:

Machine harvested leaves were collected in curing containers and bulk cured using an extended low temperature-high humidity yellowing/browning phase. After browning was judged complete the ventilators were opened and the temperature advanced to dry the leaf and the midrib.

This approach worked reasonably well except that complete browning did not occur in some of the leaves. These leaves with a mixture of brown and yellow were judged to be inferior.

We expect to continue this work in an effort to reduce drying rate so that more of the leaves will complete the transition from yellow to brown.

II. Graduate Students:

Donald Eddington, working toward Ph.D. in transplanting area.

Liang Zhu, working toward Master's degree in mechanization

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IV. Publications:

Suggs, C.W., H.B. Peel, Jr., T.N. Thomas, D.L. Eddington, J.W. Gore and T.R. Seaboch. Self-feeding transplanter for tobacco and vegetable crops. Applied Engr. in Agri. 3(2):148-152, 1987.

Suggs, C.W. Effects of tobacco ripeness at harvest on yield, value, leaf chemistry and curing barn utilization. Tob. Sci. 30:152-158, 1986.

VI. Manuscripts in Review:

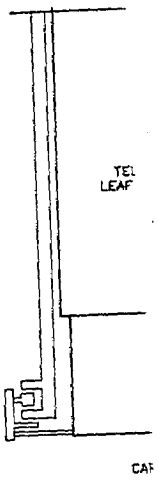
Suggs, C.W., H.B. Peel, Jr., T.R. Seaboch and K. Butler. Design and evaluation of a spreader to distribute tobacco leaves in a curing container.

VII. Papers Presented at Professional Meetings:

Suggs, C.W., D.L. Eddington, T.R. Seaboch and H.B. Peel, Jr. Automatic feeding transplanters. 32nd Tob. Workers Conf., Baltimore, MD, Jan. 12-15, 1987.
Suggs, C.W. Effects of harvest schedule on yield, price and value. 32nd Tob. Workers Conf., Baltimore, MD, Jan. 12-15, 1987.

IX. Technical assistance was provided by Hilton Peel, Tim Seaboch, S.M. Leary, Tim Woody, Kelly Butler and C. Ehilegbu.

Financial assistance for the transplanter investigation was provided in part by a grant from Philip Morris.



Figure

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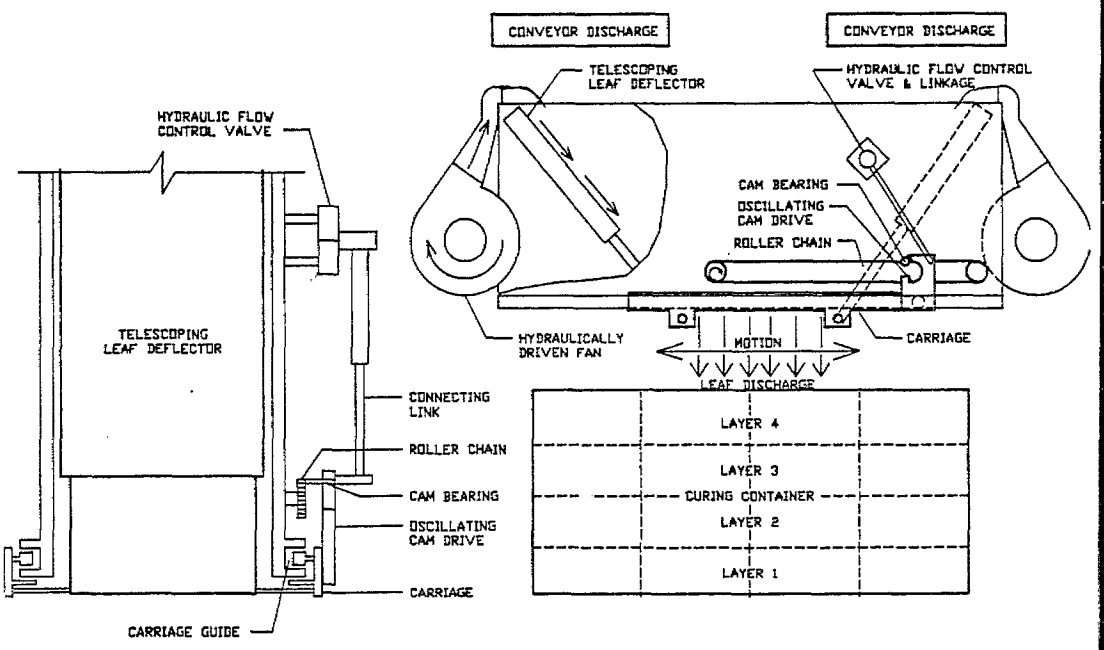

Figure 1. Leaf deflectors mounted inside the oscillating rectangular tube distribute the leaves across the face of the curing container.

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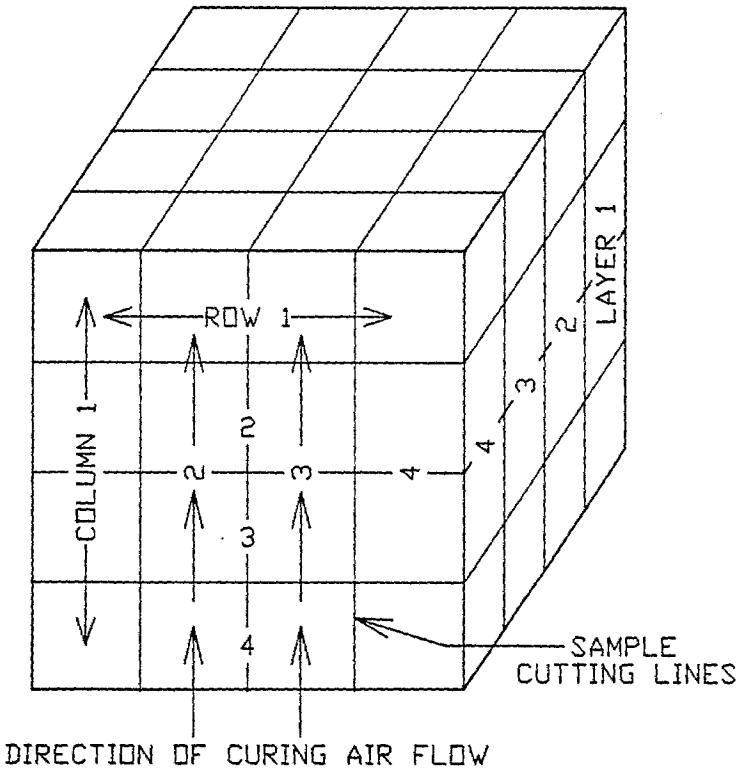

Figure 2. Each layer was cut into a four column by four row grid and weighed to determine spreading uniformity.

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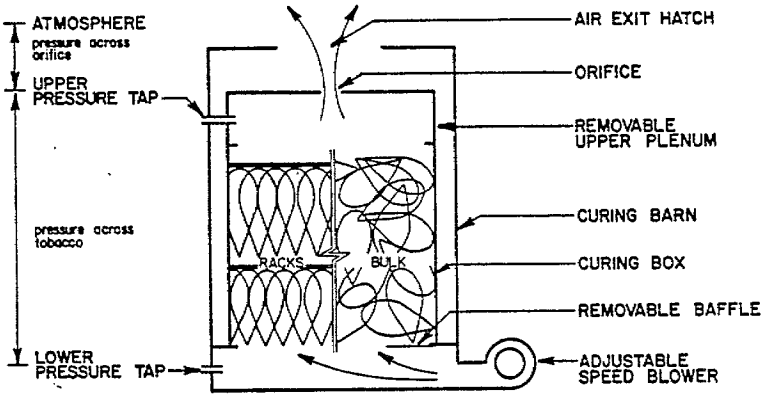

Fig. 3. Apparatus used to measure air flow. Container was loaded with either aligned leaves as shown on the left side of the figure or random leaves as shown on the right side. Lower pressure tap was actually located in side of barn rather than facing air stream as shown.

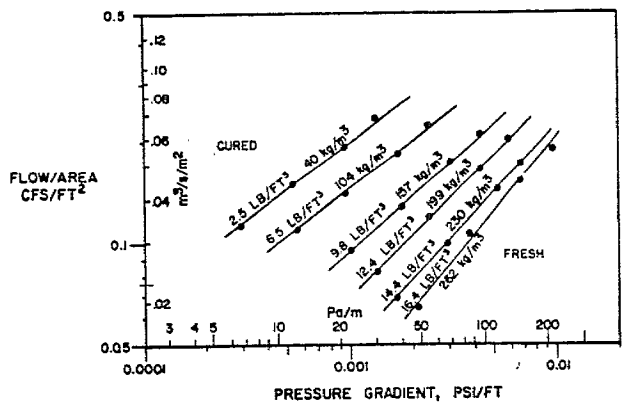

Fig. 4. Air flow increased as the bulk density of the tobacco leaves decreased due to drying, typical response.

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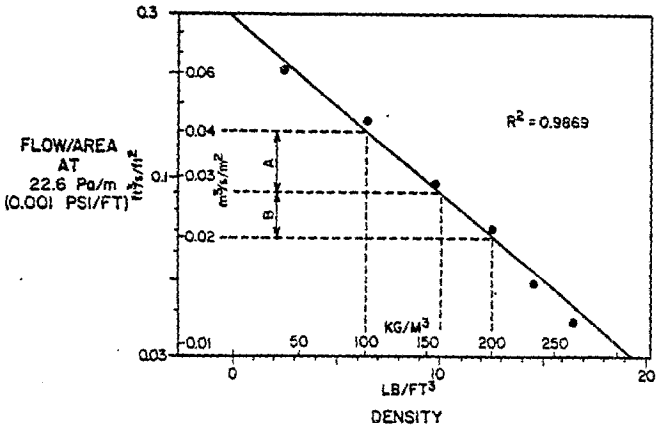

Fig. 5. Regression of flow at a constant pressure gradient on bulk density.

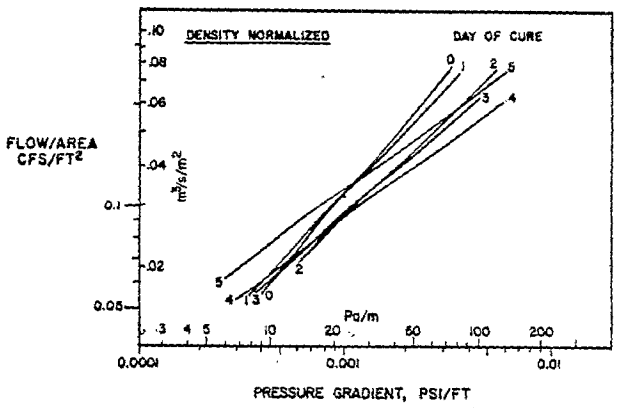

Fig. 6. Flow response lines from Figure 2 adjusted to a common density of 160 Kg/m^3 (10 lb/ft^3).

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Title: NC02136 Optimization of Tobacco Curing Systems (-9/30/87)
NC02162 Post-Harvest Processing and Handling of Flue-Cured Tobacco (10/1/87-)

Project Leaders: C. F. Abrams, Jr., C. W. Suggs, S. C. Mohapatra

I. Summary of Research:

A. Computer Monitoring and Control of Curing (Abrams)

A microcomputer-based system was designed and used for data acquisition and control in experimental curing of tobacco. This system employs proven technology for monitoring now in use in weather stations throughout the state. The system was implemented on a six unit group of small curing barns (updraft type) at the OTRS. A BASIC program was written which resides in E-PROM and records data in battery-protected RAM. Dry and wet bulb temperatures at the bottom and top of the curing units, pressure drop across the tobacco, air flow rate, inlet damper position, and furnace status are recorded at 30 min. intervals. Control was effected based on a desired curing schedule in terms of dry and wet bulb set point temperatures. The program monitored the temperatures in the top of each curing unit once every minute, activating the furnace and/or inlet damper to maintain set point conditions. A remote access feature was included to allow interrogation of the curing units by telephone.

As currently configured, the cost of the system is approximately $2,500 for the computer system and interfaces, which can handle up to 16 curing units, and about $ 350 per curing unit for damper actuators. While the immediate application is in research into alternative curing strategies, a future application may be in improving growers' management ability.

B. Fresh Shredding and Particle Curing (Abrams, Suggs)

Finely shredding whole leaf and lamina after yellowing, and then removing the remaining moisture by a modified curing schedule produced material which compared favorably with whole leaf cures on a visual basis. Shredding of lamina was more difficult that whole leaf due to problems in feeding through the cutter, and concomitant bruising was worse when the midrib was remove prior to shredding. An alternative, higher volume cutter is under design.

Limited work on particle curing underscored the potential for improvement in handling and acceptable curing of tobacco by coarse cutting. Batch yellowing before cutting improved barn space use efficiency.

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Chemical and smoking quality evaluations of the material are underway.

C. Microwave Heating and Drying (Abrams, Mohapatra)

A range of intensities and durations were investigated for heating yellowed flue-cured tobacco prior to completion of drying under normal leaf drying conditions and under natural air. Samples made up of six 73 mm dia. mid-leaf disks were treated at intensity levels of 375 and 750 W for durations of 30, 45, and 60 s, and they were then dried under a modified leaf drying schedule (normal) and in laboratory air (lab) in a full factorial experiment. The 60 s duration resulted in complete drying at the 750 W intensity while lower energy levels resulted in only partial drying of the sample leaf disks as had been found previously. Exponential drying rate constants were estimated through non-linear curve fitting of sample weight vs. time data obtained for the post-treatment interval. Post-treatment drying rate appears to be affected by treatment, more so for the material dried under natural air conditions that for that dried under curing conditions. Visual inspection of the color of the samples indicates a tendency towards browning as total energy of exposure decreases. For exposure energies exceeding 3000 J and above browning is reduced as compared to the yellow color.

Chemical analysis of the material is currently under way to investigate the potential for dry weight determination.

D. Mechanical Properties of Cured Tobacco Leaf as Related to Body and Texture (Foutz, Abrams, Suggs, Mohapatra)

Material from 13 market grades of flue-cured tobacco from the 1986 crop has been studied by materials testing methods. The tested material was classified into four primings grades [P4G, P3F, P4F, and P5F], two lug grades [X3L and X3F], four cutter grades [C4G, C4KF, C4KM, and C4F], and three leaf grades [B4GK, B4KF, and B4K]. It was obtained from a single crop which was grown in one field under standard management practices, hand harvested, and bulk-cured. The material was graded by a professional grader on a leaf-by-leaf basis so that the tolerance associated with the grades was minimal. The material represented four general stalk locations [P, X, C, and B] and four degrees of maturity [immature (for P, C, and B), unripe (for C and B), prematurely ripe (for P), and ripe (for X, C, and B)].

Moisture content was controlled to within the 14-17 % (wet basis) range by equilibrating the sample material in a controlled environment prior to testing. Test specimens were cut from the mid-section of the leaves and subjected to mechanical

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load/deformation testing at 2 mm/min. elongation rate in the direction normal to the leaf midrib. Lamina thickness was directly measured for each test specimen in order to permit computation of material strength and elasticity values on a per unit cross-sectional area basis. The modulus of elasticity (E), (E), the yield strength (S_y), the ultimate strength (S_u), and the fracture strength (S_f) were measured for 15 replicates of each grade. The means and standard deviations are reported in Table D.1.

Table D.1. Mechanical Properties of Flue-Cured Tobacco Lamina

Standard deviations given under each mean of thickness (t), moisture content (MC), modulus of elasticity (E), yield strength (S_y), ultimate strength (S_u), and fracture strength (S_f).
P = stalk position (1=primings, 2=lugs, 3=cutters, 4=leaf)
M = maturity (1=immature, 2=unripe, 2.5= prematurely ripe, 3=mature, 4=ripe)

Grade	P	M	t, mm	MC,%wb	S_u, kPa	S_y, kPa	S_f, kPa	E, kPa
P4G	1	1	.128	15.3	836	88.9	502	892
			.022	.74	139	14.1	171	200
P3F	1	2.5	.147	15.8	546	67.7	448	871
			.014	.85	163	19.8	199	185
P4F	1	2.5	.148	15.7	558	270.7	344	1005
			.022	1.05	160	149.3	193	249
P5F	1	2.5	.164	15.9	412	82.4	259	703
			.025	.75	121	77.7	132	273
X3F	2	4	.151	15.2	782	92.8	511	696
			.024	.77	144	48.6	183	176
X3L	2	4	.160	15.4	794	84.7	517	726
			.018	.97	143	17.8	152	159
C4G	3	1	.133	15.5	996	104.0	586	938
			.014	1.03	301	34.7	187	245
C4KF	3	2	.165	15.4	917	95.6	595	958
			.026	.68	186	19.6	187	287
C4KM	3	2	.161	15.6	733	81.4	493	1001
			.016	.66	153	21.5	165	275
C4F	3	4	.169	15.6	592	67.7	382	834
			.021	.76	149	25.0	157	170
B4GK	4	1	.162	15.3	743	89.3	389	790
			.021	.91	123	26.8	136	191
B4KF	4	2	.179	15.5	1050	114.6	559	774
			.011	.88	175	27.4	276	166
B4K	4	4	.159	15.4	987	113.2	522	926
			.017	.74	145	41.9	96	146

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Statistical analysis of the data indicate that thickness and ultimate strength are the most important mechanical variables which tend to discriminate between stalk positions and maturities. Although moisture content was controlled within a narrow range, it also showed significant maturity and stalk position differences; this result reflects possible differences in hygroscopic characteristics in the material by stalk position and maturity.

Work is underway with a selection of material from the 1987 crop to further develop and refine maturity and stalk position measurement models based on mechanical properties.

E. Biochemical and Biophysical Properties (Mohapatra and Mohanty)

1987 being the final year for this research, investigations were limited to electrophoretic characterization of cured leaves of known grades. Proteins were extracted from the leaves with selected buffers and the extracts were subjected to SDS-PAGE (Sodium dodecylsulfate-polyacrylamide gel electrophoresis) along with extracts from mature green (i.e. uncured) leaves. A total of 50 bands were detected in the extracts of the green leaf. Proteolysis resulted in the disappearance of certain protein bands in the cured leaf. The remaining bands appeared to be grade specific in that some of these bands were found in only one grade type but not in others. The project came to an end while this work was in progress. It is not known at this time if the putative band specific proteins are reproducible in the tobaccos carrying identical grades in different crop years.

F. Ethylene Profile of a Curing Barn (Mohapatra and Suggs)

It is well known that ethylene plays a key role in tobacco leaf development and curing. Although voluminous information exists on the relationship between ethylene and tobacco leaf developmental physiology, not much is known about the ethylene production pattern of the leaf during curing. Therefore, a study was initiated at the Central Crops Research Station to address this aspect of curing physiology. While this investigation will be conducted through several years involving various leaf positions, maturity, and curing conditions, the first year was deviated to development of an appropriate ethylene collection method. Three methods were tested: a) collection of gas samples in sealed containers, b) absorption of ethylene by mercuricperchlorate through overnight equilibrium, and c) absorption of ethylene by mercuric perchlorate through bubbling for 5 to 30 min. Samples collected according to the first method were directly injected to a Shimazu gas chromatograph fitted with a flame ionization detector (FID) and connected to a Perkin Elmer integrating printer-plotter. Samples collected according to the

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second and third methods were mixed with one ml of concentrated lithium chloride to release the absorbed ethylene, which was then injected to the gas chromatograph as described. Although the second method gave the highest amount of measurable ethylene, the volume of mercuric perchlorate was severely affected by the drying temperature of the curing barn. However, reproducible results were obtained when ethylene was collected by bubbling the curing barn head space air through mercuric perchlorate at 4C. These methods will be tested again in the coming year before one method is selected for final use.

G. Degradation Sizer Analysis (McCall, Abrams)

Work was begun January 1, 1988 on a study of the accuracy and precision of degradation sizers which are used in quality control of tobacco threshing operations. Variation in the operating conditions, maintenance and use of these units throughout the manufacturing industry results in errors in assessing the particle size of threshed lots of tobacco. Adequate bases of standardization of machines do not exist. The objective of the work is to develop a means for calibrating degradation sizers.

II. Graduate Students:

Ph.D.: S.V. Sahi (Part E; left program on June 31, 1987 due to lack of funds)
Ph.D.: Timothy L. Foutz (Part D)
M.S.: Frank C. McCall (Part G)

III. Postdoctoral Fellows:

Dr. B. Mohanty (Part E; left program on Dec.31, 1988 upon termination of project.)

V. Manuscripts Accepted for Publication:

1. Mohanty, B., and S. C. Mohapatra. Effect sample preparation methods on tobacco foliar enzymes. Tob. Sci. 32: (in press).

VII. Papers Presented at Professional Meetings:

1. Mohapatra, S. C. Comparison of methods for starch extraction and estimation. Annual Meeting, Amer. Soc. Plant Physiol., St. Louis, MO, July 19-23, 1987. Abstract #855.

2. Mohanty, B., and S. C. Mohapatra. Biophysical and biochemical parameters of tobacco quality. Tob. Chem. Res. Conf., Greensboro, NC, Oct. 5-7, 1987. Abstract #64.

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IX. Acknowledgments:

Technical Assistance and Collaboration
E. H. Wiser, Professor (Part A)
E. P. Harris, Electronics Technician (Part A)
Valsa Samuels, Laboratory Technician Parts C, E, & F)
S. M. Leary, Research Engineer (All parts)
T. W. Woody, Engineering Research Technician (All parts)
Hilton Peel, Engineering Research Technician (Part F)
Timothy Seaboch, Agricultural Research Technician (Part F)
Don Eddington, Graduate Research Assistant (Part F)
Azzedine Lansari, Graduate Research Assistant (Part D)
Susan G. Capps, Undergraduate Student (Part D)

Funding and Collaboration
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R. J. Reynolds Tobacco Company (Parts D & E)
Universal Leaf Tobacco Company (Part G)
Philip Morris USA (Part G)

Secretarial Assistance
Ann Griffin
Brenda Mason

NC 02124: INS

PROJECT LEAD

I. Summary of b

Research
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NC 02124: INSTRUMENTATION AND PROCEDURES FOR MEASURING QUALITY AND COMPOSITION OF AGRICULTURAL PRODUCTS

PROJECT LEADER: W. F. McClure
Professor

I. Summary of Research:

Research was continued during the above reporting period to test the feasibility of optical measurements for measuring properties of tobacco related to quality and composition. The work was organized as follows:

1. Spectral Searching and Matching
2. Fourier Self-deconvolution
3. Image analysis of electron-microscope pictures

SPECTRAL SEARCHING AND MATCHING

It has been established earlier that the calibrations can be improved if they are "tailored" for one tobacco type. Toward this end work was initiated to determine if, in fact, NIR analysis could be used to identify tobacco type. If this were possible, it would further enhance NIR technology by making it possible for NIR instruments, without operator intervention, to identify the tobacco type and, based on that decision, pull the appropriate calibration equations pertaining to the tobacco type. One hundred samples for each of the tobacco types (flue-cured, dark fired, Maryland and burley) were scanned on the Computerized Spectrometer (COMP/SPEC). Software was written to determine the match between the spectra and a reference spectrum for each of the tobacco types. Table 1 shows the accuracy of the search and match (SAM) analysis of the 400 samples.

Table 1. Accuracy of SAM in identifying tobacco types from NIR spectral data

		DATA TREATMENT			
		FO	D1	D2	PW
T	FLU	100	100	100	99
Y	DRK	100	100	100	100
P	MAR	83	92	92	38
E	BUR	84	94	97	84

There were four spectral data treatments: FO, Fourier coefficients; D1, $\frac{d(\log\frac{1}{R})}{d\lambda}$; D2, $\frac{d^2(\log\frac{1}{R})}{d\lambda^2}$ and PW, power spectrum values. We conclude from the data that better than 92% accuracy in identifying tobacco types is achievable using the D2 data treatment (see column 3 in the

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above data set). We further conclude from this study that it is possible to identify tobacco types using NIR data, making it possible for us to incorporate this feature into the "intelligence" of NIR machines.

FOURIER SELF-DECONVOLUTION

Fourier self-deconvolution is a means of enhancing the absorption bands of NIR spectra when the spectrometer lacks the resolution to do it. A total of 200 samples of tobacco were scanned for this study. Software was written to perform the Fourier self-deconvolution for each of the 200 spectra. Preliminary results indicate that the accuracy of NIR calibrations for nicotine and moisture can be improved by using Fourier self-deconvolution to do band enhancement before calibrations are developed.

IMAGE ANALYSIS OF CELLULAR STRUCTURE OF TOBACCO

AGVISION, a custom-built image analysis system was programmed to compute fractals of images of the cellular structure of cured tobacco as recorded with an electron microscope. Images of a number of samples were analyzed, by Abrams and Mohapatra, using the software developed. Results of this study will be reported by Abrams.

SUMMARY AND CONCLUSIONS

Funding for this phase of the project was terminated on June 30, 1987. Therefore, this is a summary of findings and conclusions of work up to that date.

COLOR

Near infrared spectrometry (NIRS) can be used to determine the color of tobacco. The spectral region between 900 and 1800 nanometers is sensitive to color change and can be used as an indicator of color of raw leaf as well as color changes due to redrying the leaf. NIR measurements of color are much easier to incorporate than the usual color matrix measurements (chromaticity coordinates).

BODY

NIRS is suitable for measuring body of tobacco as it relates to stalk position and chemistry. It was shown that chemistry of tobacco relates to stalk position. Since NIRS is suitable for measuring chemistry, it was not surprising that it was a suitable tool for measuring stalk position. This leads to the conclusion that, since traditional measures of quality are an attempt to judge the chemistry of tobacco leaves, it would be more appropriate to use NIRS to directly measure the chemical profile of tobacco, thus eliminating the problem of poor judgments in traditional evaluations.

TEXTURE and GRADE

NIRS was found to be suitable for measuring texture and grade of tobacco as these properties relate to chemistry of the leaf material. Samples used for this study were limited and traditional evaluations of texture were vague. This again points out the need to use a direct measurement of chemistry as a part of our grading system. Preliminary light scattering experiments indicate good correlation with texture of tobacco.

II. Graduate Stu

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III. Publications

1. McC

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II. Graduate Students:

1. Roger M. Hoy: Correlation of Optical Measurements of Tobacco Characteristics with Traditional Evaluation of Quality.

2. M. Scott Howarth: Computer Vision Systems for Evaluating Quality Factors of Agricultural Products

3. Sue E. Nokes: Multivariate Analysis of Near Infrared Spectra as Related to Measuring the Composition of Agricultural Products

4. Steven K. Taylor: Interfacing AGVISION (a custom-built computer vision system) to a X-Y-Z robot

5. Dae Weon Lee: Development of spectral computer vision for measuring the quality of tobacco and other agricultural products

III. Publications

1. McClure, W. F. 1986. Status of near infrared technology in the tobacco industry. In *Recent Advances in Tobacco Science: Advances in the Analytical Methodology of Leaf Smoke*" (Eds. R. F. Severson, Dale E. Mathis, and Richard A. Manning) 12:3-53. 40th Tobacco Chemists' Research Conference, Knoxville, TN.

2. Williamson, R. E. and *W. F. McClure*. 1986. Rapid spectrophotometric analysis of the chemical composition of tobacco. Part 4: Total Nitrogen. Tob. Sci. 30: 109-111.

3. Davies, A. M. C. and *W. F. McClure*. 1985. Near infrared analysis of foods. Analytical Proceedings (England) 22:321-322.

4. Paulsen, M. R. and *W. F. McClure*. 1986. Illumination for computer vision systems. Trans. of the ASAE 29(5):1398-1404.

5. McClure, W. F. and A. M. C. Davies. 1987. Fourier self-deconvolution in the analysis of near-infrared spectra of chemically complex samples. Proceedings of the 6th International Conference on Fourier-transform Spectroscopy (Vienna, Austria) 6:33-35.

6. McClure, W. F. 1987. Near-Infrared Instrumentation. (Chapter 5 in Near-Infrared Technology in the Agricultural and Food Industries, Eds. P. C. Williams and K. H. Norris). American Association of Cereal Chemists, Inc., St. Paul, MN.

7. Whitaker, T. B., H. E. Pattee, *W. F. McClure* and J. W. Dickens. 1987. Measuring peanut maturity using near infrared reflectance. In *Peanut Quality: Its Assurance and Maintenance from the Farm to End-Product (Tech. Bulletin 874).* Agricultural Experiment Station, Institute of Food and Agricultural Sciences, University of Florida, Gainesville.

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IV. Manuscripts in Review:

1. Godshalk, E. B., *W. F. McClure*, J. C. Burns, D. H. Timothy and D. S. Fisher. 1986. Heritability of cell wall carbohydrates in switchgrass. In preparation for publication in Crop Science.

2. de Ruiter, J. M., J. C. Burns, *W. F. McClure* and D. H. Timothy. 1986. Prediction of cell wall carbohydrates and quality in Panicum species by near infrared reflectance spectroscopy.

3. Whitaker, T. B., H. E. Pattee, *W. F. McClure* and J. W. Dickens. 1986. Predicting peanut maturity using near infrared reflectance.

4. Davies, A. M. C. and *W. F. McClure*. 1986. Near Infrared Spectroscopy.

5. McClure, W. F. and A. M. C. Davies. 1986. Correcting for bias and skew in near infrared calibrations.

6. McClure, *W. F. and* A. M. C. Davies. 1986. Fourier analysis or near infrared spectra.

7. Gao, Wenyu and *W. F. McClure*. 1986. Near infrared measurements of the chemical composition of dark fired tobacco.

8. Gao, Wenyu and *W. F. McClure*. 1986. An agricultural robot for sorting sweet potatoes.

9. McClure, W. F. 1987. Fourier self-deconvolution enhances near infrared spectroscopy.

10. Sun, Ting Cong and *W. F. McCLure*. 1987. Strain gauges provide tactile sensing on pneumatic grippers.

V. Papers presented at professional meetings:

1. McClure, W. F. 1986. Correlation transform spectroscopy in Fourier space: Spectral searching and matching. Federation of Analytical Chemists and Spectroscopy Societies (FACSS). St. Louis, MO (September 26-October 3).

2. McClure, W. F. 1986. Correlation transform spectroscopy in Fourier space: Derivative enhancements in Fourier space. Federation of Analytical Chemists and Spectroscopy Societies (FACSS). St. Louis, MO (September 26-October 3).

3. McClure, W. F. 1986. Derivative enhancements in Fourier space. The Rocky Mountain Conference on Analytical Chemistry and Applied Spectroscopy. Denver, CO (August 4-7).

4. McClure, W. F. 1986. The use of Fourier transforms in near infrared spectroscopy. 3rd International Diffuse Reflectance Conference. Chambersburg, PA (August 17-22).

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5. McClure, W. F. 1986. Status of near infrared technology in the tobacco industry. 40th Tobacco Chemists' Research Conference. Knoxville, TN (October 13-16).

6. McClure, W. F. 1986. Electronic measurements of the quality and composition of tobacco. International Tobacco Exhibition and Conference. Richmond, VA (September 16-18).

7. McClure, W. F. 1987. Near Infrared Analyses of the Chemical Composition of Tobacco: Objective Measurement of Quality on the Auction Floor. Tobacco Workers Conference. Baltimore, Maryland (Jan. 12-15).

8. McClure, W. F. 1987. Analysis of NIR spectra in Fourier space: Band enhancements *via* derivative and self-deconvolution. Analytical Chemistry Conference. Denver, Colorado (April 5-8).

9. McClure, W. F. 1987. Fourier self-deconvolution enhances NIR spectra. The Pacific Scientific Conference. Rockville, Maryland (May 4-5).

10. McClure, W. F. 1987. Using the NCSU software package in NIR analyses. The Pacific Scientific Conference. Rockville, Maryland (May 4-5).

VI. Graduate Student Theses Completed During Reporting Period:

Howarth, Scott M. 1987. Development of software for analyzing images of agricultural products. Masters Thesis. North Carolina State University.

VII. Visiting Professionals:

Gao, Wenyu. Visiting Scholar. Huazhong Agricultural College. Wuhan, Peoples' Republic of China.

VII. Acknowledgements:

Research conducted during this reporting period was supported, in part, by the North Carolina Tobacco Foundation and R. J. Reynolds Tobacco Company.

Appreciation is expressed for the continued support and cooperation of Dr. R. E. Williamson, USDA/ARS; Dr. W. W. Weeks, Crop Science Department and Dr. Peter Bloomfield, Department of Statistics.

Special appreciation is given to Mr. Mike McLester, Electronic Technician for his support and encouragement in these studies.

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Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

Title: NC 06033 Expert Systems and Computer Modeling for Agricultural Production Decision Management

Project Leader: R. S. Sowell

Summary of Research:

During 1986-87 two expert systems shells, Insight II (by Level five Research, Inc.) and Personal Consultant Easy (by Texas Instruments, Inc.) were acquired for evaluation as to their appropriateness for use in developing expert systems for crop production decisions. This evaluation has continued during 1987-88. The evaluation of these products revealed powerful devices for the development of expert systems. There were, however, limitations with both software packages. These limitations included difficulties with interfacing variables to external programs, development of usable working copies for distribution, and formatting of system screen inquires for accurate and understandable user interaction. These problems have been dealt with through the recent purchase of Personal Consultant Plus, an extension of the Personal Consultant Easy software.

Personal Consultant Plus is being utilized in graduate studies in the development of an expert system for the selection of irrigation systems for farms under production of tobacco along with other crops. To date in this project, research has centered around the development of calculations, procedures, and data which are pertinent to the project. The data collection process has included work with soil and soil-water properties, crop water use, crop response to irrigation, climatological properties, and costs of various irrigation materials and systems. The development of calculations and procedures includes evaluation of all analytical procedures and 'rules-of-thumb' for the analysis and implementation of the most efficient, feasible and cost effective irrigation units and systems for various cases and situations.

A tobacco disease expert system was completed previously as an undergraduate project. This system is currently being transferred from its development as an Insight II product to the Personal Consultant Plus package. This procedure also includes a restructuring and upgrading of the original product.

The future goal upon completion of these products is to distribute them through teaching workshops in conjunction with the North Carolina Extension Service. The planned distribution time frame currently is set for the summer of 1988.

Graduate Student: T. Bradley Bennett

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Title: NC 03919 Characterization of Meristem Morphogenesis in Response to Changes in Environment and Age: Metabolic Activity in the Shoot Apex of Nicotiana tabacum in Relation to Leaf and Floral Initiation.

Project Leader: Judith F. Thomas

I. Summary of Research:

A. To characterize metabolic features of the apical meristem of tobacco plants as growth progresses from the vegetative to reproductive stage of development under various photoperiod and temperature regimes.

B. To relate patterns of metabolic activity to recently determined ultrastructural features of the shoot apex associated with floral evocation in the short-day isoline, NCTG-22 and its day neutral counterpart, NC2326.

Succinate dehydrogenase (SDH) activity was determined in fresh-frozen, cryostat sections of the shoot apical meristem of Nicotiana tabacum L. cv. NCTG-22 to indicate citric acid cycle pathway capacity. Plants were grown in controlled-environment chambers of the NCSU Phytotron and exposed to inductive short-day and non-inductive long-day photoperiods after a six-week juvenile phase. To determine SDH activity, frozen sections were cut at 16 um , air-dried, incubated for 90 minutes at 35°C in a solution of sodium succinate, nitroblue tetrazolium, and phosphate buffer (NBT) at pH 7.2. Twenty-five stained median sections from different meristems were selected at each developmental stage (vegetative, transition, and floral). Counter-stain and control treatments were applied. The experiment was repeated twice.

SDH activity was very low at the beginning of the short-day treatments and was more prevalent in leaf primordia than the apex. SDH activity was low in the corpus and very low in the tunica in the vegetative meristem. An increase in SDH activity occurred during evocation. In the transition apex, SDH activity was highest in the peripheral zone, central mother cells and in a cambial-like transitional zone in the rib meristem, and lowest in the tunica. The dark blue diformazan granules which were localized in these zones gave the appearance of a circle of high SDH activity surrounding a quiescent center of low activity. This pattern of activity was confirmed in stained cross sections of apices at this stage of development. At the early floral stage, greatest SDH activity was located in the terminal floret primordium and axillary inflorescence primordia. High SDH levels were evident, successively, in incipient terminal floret primordia, sepal, petal, stamen, and carpel primordia as differentiation of each set of organs progressed.

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Even though the length of the transition period is much longer under non-inductive photoperiod treatments, the patterns of SDH activity were observed to be similar to those that occurred under inductive short-day photoperiods.

The changes in SDH activity appeared to correspond to the changes in meristem morphology and cytology. SDH activity in the epidermal and subepidermal cell layers was primarily observed at the sites where further leaf primordia or floral bud primordia might be formed. The results suggest that an evoked meristem requires a more actively functioning citric acid cycle pathway. The study further supports the hypothesis that respiratory rates increase in apical meristems during the transition to flowering.

II. Graduate Student(s): Chung-Cheng Lu, Ph.D. (Botany)

IV. Publications:

Kanchanapoom, M. L. and J. F. Thomas. 1987. Stereological study of ultrastructural changes in the shoot apical meristem of Nicotiana tabacum L. during floral induction. Amer. J. Bot. 74: 152-163.

Kanchanapoom, M. L. and J. F. Thomas. 1987. Quantitative ultrastructural changes in tunica and corpus cells of the shoot apex of Nicotiana tabacum during the transition to flowering. Amer. J. Bot. 74: 241-249.

V. Manuscripts Accepted for Publication:

Raper, C. C., Jr., J. F. Thomas, L. Tolley-Henry, and J. W. Rideout. Assessment of availability of soluble carbohydrates and reduced nitrogen during floral initiation in tobacco. Bot. Gaz. 149 (in press)

VI. Manuscripts in Review:

Kanchanapoom, M. L. and J. F. Thomas. Meristematic activity in the shoot apex of Nicotiana tabacum during floral evocation. Bot. Gaz.

VII. Papers Presented at Professional Meetings:

Lu, Chung-Cheng and J. F. Thomas. Succinate dehydrogenase activity in the shoot apex of tobacco during floral initiation. An abstract of a paper presented to the annual meeting of the American Society of Plant Physiologists, Reno, NV, July 10-14, 1988.

Title: 03917

Project Leader

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N. C. Long, an

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Title: 03917 - INVESTIGATIONS IN TOBACCO TRANSPLANT PRODUCTION

Project Leader: R. C. Long

Physiology of the Growth and Development of Burley Tobacco (P. E. Barney, R. C. Long, and C. M. Sasscer)

In 1987, plantings of Ky 14 burley tobacco were grown under standard cultural practices at the Waynesville Mountain Research and the Reidsville Upper Piedmont Research Stations. Plants were sampled on a weekly basis at three leaf positions during the period from the grand growth phase through harvesting and curing. Samples were analyzed for various enzyme activities involved in carbon and nitrogen metabolism. The samples have also been dried and ground for chemical analyses.

Protein concentration and ATP sulfurylase activity, the enzyme involved in the first step of sulfate assimilation, declined throughout the season. Nitrate reductase and glutamine synthetase activities, both involved in nitrate assimilation, peaked during maturation of the crop and steadily declined during senescence and curing. Alpha-amylase and protease activities, remained low through most of the season, increased gradually prior to harvesting, and increased greatly during curing.

These data suggest that the patterns of carbon and nitrogen metabolism in burley tobacco are similar to those observed in flue-cured tobacco, yet the changes are not as dramatic, particularly for the nitrogen metabolism enzymes. For example, nitrate assimilation and accumulation typically occur at times of maximum growth rates during mid summer; in the present study, the enzymes involved in nitrate assimilation in burley also peaked in activity during this period. In contrast to flue-cured tobacco whose nitrate reductase activity approached zero immediately thereafter, the activity in burley remained high and rather constant until harvest. Although starch degradation to sugars occurs during senescence and is accelerated during flue-curing, little change was observed in amylase activity in burley until the onset of air-curing.

Potential of Clipping and Undercutting to Assist in Transplant Pulling (R. C. Long)

A number of tobacco plantbeds at the Borderbelt and Upper Piedmont Research Stations were clipped a variable number of times before being undercut. The plants were pulled and counted to determine the percentage usable transplants at that pulling. The data are given in Table 1.

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Table 1. Potential for Undercutting and Pulling of Transplants in High Usable Percentage

Date Pulled	Area	Var.	No. Times Clipped	Reps	No. plants/ft^2 Opt. Size**	Too Small***	Too Small Left in Bed	% Usable (of Total)	$\bar{x}$ Sd	% Usable (of Pulled)	$\bar{x}$ Sd
5/5/87	W-1*	G-28	~6	8	32	18	-	64.3	9.7	-	-
5/5/87	W-2*	K-373	~8	8	33	14	-	70.0	9.7	-	-
5/7/87	W-3*	K-373	~10	8	47	8	4	79.4	8.3	86.0	8.4
5/5/87	W-4	G-28	0	2				30.1			
5/28/87	R-1+	McN-944	0	4				29.5	11.8		
5/28/87	R-1+	McN-944	3	4				51.0	17.4		
6/4/87	R-2++	McN-944	3	-						~90	

*Beds never pulled previously; approximately 40 linear ft. of beds undercut at 2" depth; 1ft.^{2} area of beds pulled clean of all plants including very small plants (except as noted in W-3); optimum size plants were easy to pull in bunches and many of the very small plants remained on the beds when plants were pulled in bunches.

**Optimum size: 10-17 cm (soil line to bud)

***Too Small: <10 cm (soil line to bud)

+Beds undercut at 2" depth.

++Beds pulled over 3 times previously; undercut at 2" depth; about a half dozen bunches of plants were pulled up and counted for usable size plants; however, not done scientifically and no data recorded.

**W=Borderbelt Station, R=Upper Piedmont Station

In summary, 1) there is an apparent correlation between the number of clippings and the percentage usable transplants pulled on one day; b) the uniformity of plants (i.e., percent usable plants) appears to be related to the early date at which clipping is started and the frequency of clipping thereafter; c) the uniformity of plants produced by early and frequent clipping is sufficiently high to suggest that beds could be pulled in one pass and that some sorting could be done as the plants are placed in boxes and the remainder of the sorting to take place on the transplanter; and d) about one-third of the small plants (e.g., very small plants) tend to remain in the bed when plants and undercut and the plants pulled in bunches. This further suggests that a chain-belt conveyor mechanism would be effective in allowing some of the very small plants to drop through, thus increasing further the percentage of usable plants that could be placed into boxes without prior hand sorting.

Effect of Clipping and Alar Combinations on Plantbed Seedling Growth (R. C. Long and T. A. Bartholomew)

Previous years' data have shown the efficacy of Alar as a means of restricting shoot elongation rate, increasing tobacco seedling uniformity, and extending the length of the transplanting "window." The latter consequence could prove to be of immense value under either cold or wet environmental conditions which delay transplanting. An important economic benefit is the fact that increased seedling uniformity also increases significantly the percentage of seedlings in the plant bed that can be transplanted, thereby decreasing the plantbed yardage necessary to transplant an acre of tobacco.

Replicated tests were conducted at the Border Belt and Upper Piedmont Research Stations to determine the effect of Alar in combination with clipping. Beds were clipped either two or three times beginning at about two inches height. Several days following the last clipping, and about 10 days before anticipated transplanting, Alar was applied (at the rate used in previous Alar studies to the plantbeds.

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Usable Percentage

le	-	% Usable	-
al)	Sd	(of Pulled)	Sd
	9.7	-	-
	9.7	-	-
	8.3	86.0	8.4
	11.8		
	17.4		
		~90	

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As expected, clipping improved plant uniformity. Uniformity was improved somewhat by the addition of Alar to the clipping treatment but the principal effect was to restrict the rate of shoot elongation (relative to clipping alone) and to delay transplanting date. Thus, the combination treatment improved uniformity over either clipping or Alar alone, lengthened the transplanting window, and delayed transplanting. If such combinations were to be used, but normal transplanting dates to be maintained, then either seeding time would need to be advanced or plantbed covers handled in a manner to promote earlier germination or growth.

Further combination tests will be conducted in 1988 to confirm these results and to refine the number of clippings necessary and the timing of the Alar application to promote greatest uniformity.

At this time, Alar is not approved for use on tobacco. It is, however, approved for use on tomato seedlings either in the greenhouse or seedbed, but not in the field once they have been transplanted, for purposes of restricting shoot elongation and to promote stem thickening.

Bed Forming and Fumigation of Narrow Row Plantbeds (R. C. Long, T. A. Bartholomew, George Clark, and Kimball Brock)

Plots initially used for the protein production studies at the Border Belt Tobacco Research Station were made up by the same method used for plantbeds (i.e., disk, harrow, hand-rake). In later years, we used a 6 ft. Ferguson Tilrovator with a 5 ft. bed former to make up the beds (plots). We also began using roll Reemay on the beds after removal of the perforated plastic in mid-spring. The success of those procedures in providing good germination and improving plant uniformity then led the Station into clipping. In 1986 and 1987, all plantbeds on the Station were prepared in the fall with the bed former; after manually covering the beds with plastic, they were surface fumigated with methyl bromide.

In 1987, the tilrovator/bed former was modified as follows: 1) The rear opening of the bed former was narrowed to 4 ft. and the collector and bed forming pans were lined with a smooth one-quarter inch polyethylene sheet. 2) Six injectors six inches in length were mounted under the front of the forming pan. A rack was mounted on the tilrovator to hold the 98% methyl bromide and dry nitrogen tanks. An electric solenoid driven from the tractor's battery was connected to the piping system and an on/off switch was mounted near the driver for his control of the fumigation operation. 3) A device was constructed and mounted on the rear tool bar of the tilrovator which provided cultipacking of the bed and covering of the bed with polyethylene. The cultipacker assembly was constructed from 10-inch Brillion cultipacker wheels (with a one-half inch V-projection) mounted 2.25 inches on center. The polyethylene laying part of the device allowed 66 inch wide film to be unrolled and laid down immediately behind the cultipacker and both edges to be covered with a small roll of soil thrown up by a rolling coulter. The entire device was designed to be dismounted from the tilrovator and remounted onto another tool bar so that either cultipacking or plastic/Reemay-laying could be performed as separate operations.

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The machine was tested and then used to make up all plantbeds on the Station in the fall 1987. To provide sufficient bed height, the land was first prepared in a normal fashion (e.g. breaking, disking). Immediately prior to bedforming/fumigation, the land was disked to throw up a ridge of soil on 8 ft. centers and was then lightly harrowed. The beds were then formed (on 8 ft. centers), fumigated, cultipacked, and covered with plastic in one pass.

Methyl bromids (98%) was injected at the rate of approximately 6 lbs. a.i./100 square yards (0.059 orifice; 40 lbs. psi; 2 MPH). Two gauges of plastic were used: embossed 1.25 mil and plain 2 mil. Both were applied successfully with the machine. It appeared the embossing of the thinner material imparted a strength to it that made it about as strong as the 2 mil plastic. We also found that cutting longer rolls of plastic to 66 inch length with a bandsaw resulting in some melting together of edges of the plastic which resulted in tearing of the plastic as it came off the roll. Hendrix and Dail advised it could be cut with a two-man crosscut saw or a chainsaw. The crosscut saw worked well; this procedure probably will need to be used if it becomes necessary to cut down rolls of Reemay to shorter length.

Excellent results were obtained at the Border Belt Station. The soil moisture was sufficient to prepare a good bed and to cultipack it. And the land was reasonably clean and free of large clumps of vegetative material. It was necessary to move the fumigation injectors to the very front of the collector pan (immediately behind the tilrovator tines) to prevent trenches from being formed behind the injectors rather than the desired smooth bed. A brush was also mounted so as to remove soil from the cultipacker. Without the brush, there was a tendency for the cultipacker to pick up and accumulate soil particles which ultimately left holes or valleys in the bed.

In addition to the plantbeds at the Border Belt Station, over 500 yards of beds were also prepared at the Oxford Tobacco and Upper Piedmont Research Stations during the fall using this apparatus.

In general, it is apparent that proper preparation of the plantbed site must be given, beginning during the summer when the cover crop is planted if this method of forming beds is to be successful. Specifically, the plantbed area should be irrigated if necessary to seed and establish the cover crop (in most cases, soybeans). Later, when it becomes time to break the area, irrigation may again be necessary to provide proper soil moisture for tillage and decomposition of vegetative material. In one situation, we found that a grassy annual weed, that had been turned under late because of dry weather, prevented establishment of a smooth bed by collecting around the injectors, resulting in unacceptable trenches in the bed. A soil moisture level that is acceptable for normal fumigant injection is also adequate for this procedure including bed forming.

GRADUATE STUI

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Tucker, M. A.,
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GRADUATE STUDENTS:

Huang, C. H. (Taiwan), M.S. (returned home before degree completed), under R. C. Long.
Pfeiffer, I. (Spain), Ph.D., under R.C. Long and W. W. Weeks.
Wan Mamat, Zaki (Malaysia), M.S., under R. C. Long.
Wu, Z. (People's Republic of China), M.S., under W. W. Weeks and R. C. Long.

POSTDOCTORAL FELLOW:

Barney, Paul E., Jr.

MANUSCRIPTS:

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Danehower, D. A., R. C. Long, M. T. Core, R. R. Izac, and H. J. Grubbs. Changes in Z-abienol levels during growth, maturation, and curing of Oriental and Southern American tobacco. Tob. Sci. (In press).

PAPERS PRESENTED AT PROFESSIONAL MEETINGS:

Tucker, M. A., G. F. Peedin, and R. C. Long. Effects of harvest maturity and nitrogen rate on some agronomic and chemical characteristics of flue-cured tobacco. 32nd Tobacco Workers' Conference, Baltimore, MD. 1987.

Weeks, W. W., and R. C. Long. Effects of air- and flue-curing on neutral volatiles and sensory evaluation of several tobacco types. 41st Tobacco Chemists' Research Conference, Greensboro, NC. 1987.

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Title: NC05563 - Burley Tobacco Breeding and Genetics

Project Leader: Rebeca C. Rufty

A. Breeding for Virus Resistance
(with G. V. Gooding, Jr., and E. A. Wernsman)

Forty-three backcross families (BC_1) derived from the cigar-wrapper cultivar Hanava 307 were developed using Ky 14 as the recurrent parent. These families were evaluated in 1987 for resistance to tobacco etch virus (TEV) at the Mountain Research Station and for resistance to tobacco vein mottling virus (TVMV) at the Upper Mountain Research Station. Genotypes were selected based on resistance to each of the viruses as well as superior agronomic characteristics and backcrossed again (BC_2) to Ky 14. BC_2 families will be evaluated under field conditions in 1988.

B. Breeding for Black Shank Resistance

Breeding lines in the F_3 generation and segregating families in the F_2 generation were evaluated for black shank (Phytophthora parasitica var. nicotianae) resistance in a disease nursery located at Rocky Mount, North Carolina. Forty-five highly resistant genotypes were selected in 1987 and will be progeny-tested in 1988.

C. Breeding for Blue Mold Resistance
(with E. A. Wernsman and C. E. Main)

Thirty-one burley tobacco breeding lines in the F_5 generation were evaluated in 1987-1988 for blue mold (P. tabacina) resistance at three locations: Gurabo, Puerto Rico, and San Andres Tuxtla and Papantla, Mexico. Breeding lines, derived from crosses of resistant cultivar Ovens 62 x susceptible cultivars Ky 17 and Ky 15, were planted at each location in a Randomized Complete Block design with three replicates. Evaluations for blue mold reaction were performed in December 1987 and January 1988. The experiment at Gurabo, Puerto Rico, was lost due to black shank (Phytophthora parasitica var. nicotianae) and flooding. Excellent results were obtained at the two Mexican sites where a Ridomil-resistant strain of P. tabacina prevails. Susceptible cultivars Ky 15, TN 86, and Ky 17 exhibited disease levels ranging from 20 to 53% leaf area damaged. Resistant cultivar Ovens 62 exhibited a 7% leaf area damaged. There were 12 highly resistant burley breeding lines with disease reactions equal to or lower than those of Ovens 62. Resistant lines will be self-pollinated and advanced to the F_6 generation for further evaluation. In addition, these lines will be used as resistant parents in a second cycle of breeding.

In summary, genetically-stable burley tobacco lines have been identified which offer a high degree of resistance to tobacco blue mold. These lines appear to be resistant to both Ridomil-sensitive and Ridomil-resistant strains of the blue mold fungus.

The components of partial resistance to tobacco blue mold were also evaluated. Two susceptible and four resistant tobacco genotypes

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were evaluated for components of partial resistance to tobacco blue mold. Inoculation efficiency, incubation period, lesion diameter, latent period and sporulation capacity were measured in experiments conducted at the North Carolina State University Phytotron. Genotypes were significantly different for all components of resistance. Resistant genotypes produced fewer and smaller lesions, had a lower degree of sporulation and exhibited longer incubation and latent periods. Results corroborated field observations and indicate that deployment of blue mold resistant germplasm should greatly reduce onset and progress of blue mold epidemics. Furthermore, the probability of rapid development of new races of P. tabacina may be reduced because resistance interferes with several different stages of the pathogen's development.

D. Breeding for Angular Leaf Spot Resistance
(with Mary Jo Wannamaker)

A greenhouse technique was developed to screen tobacco genotypes for angular leaf spot resistance. The effects of inoculation method, bacterial concentration, and mist were evaluated. An artist's air brush proved to be the most effective method of administering inoculum. A bacterial suspension containing 3.0-9.0 x 10^7 cfu/ml produced symptoms typical of those observed in the field. A mist period of 0-18 hours prior to inoculation had no influence on disease development on the four cultivars tested. Post-inoculation mist period of 24, 36, and 48 hours greatly increased the amount of disease. A quantitative disease assesment scale permitted classification of genotypes for disease reaction. The similarity between symptoms produced in the greenhouse and field symptoms indicates that screening for angular leaf spot resistance should be feasible under greenhouse conditions.

II. Graduate Students:

Wannamaker, Mary Jo. Ph.D. candidate, Crop Science Department. Genetics investigations on the angular leaf spot disease of tobacco caused by Pseudomonas syringae pv. tabaci.

IV. Publications:

Murphy, J. P., Cox, T. S., Rufty, R. C. and Rodgers, D. M. 1987. A representation of the pedigree relationships among flue-cured cultivars. Tob. Sci. 31:70-75.

Wernsman, E. A. and Rufty, Rebeca C. 1987. Tobacco. In: Principles of Cultivar Development: Crop Species. W. H. Fehr (ed.) MacMillan Publishing Co., Inc., New York, NY. pp 669-698.

V. Manuscripts Accepted for Publication:

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Reinert, R. A., Rufty, R. C., and Eason, G. 1988. Interactions of tobacco etch or tobacco vein mottling virus and ozone on biomass changes in burley tobacco. J. Env. Qual. (In Press).

VI. Manuscripts in Review:

Rufty, Rebeca C., Wernsman, E. A., and Gooding, G. V., Jr. 1988. Inheritance of resistance to tobacco etch virus in Nicotiana tabacum L. cultivar Havana 307. Plant Disease (In Review).

Rufty, Rebeca C., Miller, Robert H., and Gooding, G. V., Jr. 1988. Evaluation of burley tobacco genotypes for tolerance to tobacco etch and tobacco vein mottling viruses. Plant Disease (In Review).

VII. Papers Presented at Professional Meetings:

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Rufty, R. C., Miller, R. D., and Gooding, G. V., Jr. 1987. Evaluation of burley tobacco genotypes for tolerance to tobacco etch and tobacco vein mottling viruses. The 32nd Tobacco Workers' Conference, Baltimore, MD, January 6-9, 1987.

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Rufty, Rebeca C., Wernsman, E. A., and Main, C. E. 1988. Breeding for blue mold resistance - host genetics. International Symposium on the Blue Mold Disease of Tobacco. February 14-17, 1988. Raleigh, NC.

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Wannamaker, M. J. and Rufty, R. C. 1987. A screening technique for angular leaf spot resistance of tobacco. Phytopathology 77:1710. (Abstract).

Wernsman, E. A., Rufty,
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IX. Acknowledgements:

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Wernsman, E. A., Rufty, R. C., and Main, C. E. 1988. Strategies for deploying blue mold resistance mechanisms. International Symposium on the Blue Mold Disease of Tobacco. February 14-17, 1988. Raleigh, NC.

IX. Acknowledgements:

I thank the North Carolina Foundation, Inc. and R. J. Reynolds Tobacco Company for financial support. Appreciation is expressed to Carroll Sasscer and Susan Corda for their assistance.

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Title: NC 05545 Genetic Investigations of Tobacco and the Nicotiana Species

Project Leader: V. A. Sisson

I. Summary of Research:

The overall objectives of this program are to:

i) Acquire, maintain, and distribute tobacco germplasm;

ii) Evaluate and characterize items in the germplasm collection;

iii) Investigate the genetics and improvement of tobacco germplasm for production, quality, and safety;

v) Adopt and develop novel methodology to provide additional ways to modify and utilize diverse germplasm.

A. Development of Disease Resistant Germplasm.

The most effective source of resistance to potato virus Y (PVY) comes from a breeding line developed in West Germany referred to as Virgin A Mutant (TI 1406). Efforts to incorporate this source of resistance into U. S. cultivars has met with mixed results. Several negative factors, including

Table 1. Reaction of doubled haploid lines to severe strains of PVY and TEV.

		PVY			TEV		
Entry	Flue-cured Parent	Stunting (%)[a/]	Necrosis (%)[b/]	Mosaic[c/]	Stunting (%)[a/]	Necrosis (%)[b/]	Mosaic[c/]
DH 51	NC 82	0	0	1	0	2	2
130	McN 944	0	0	1	0	0	1
215	NC 82	0	1	2	0	5	2
281	Coker 48	0	2	2	70	50	5
283	NC 82	30	50	4	10	2	2
Hav 307		0	0	1	0	0	2
NC 82		70	50	5	90	70	5
McN 944		90	60	5	80	60	5

a/ Comparison between inoculated and uninoculated plants; i.e. each number refers to the percent reduction in overall aerial plant mass.
b/ Percent of the leaf area that was necrotic.
c/ Degree of symptoms. F=mild; S=severe

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greater susceptibility to chewing insects, enhanced sensitivity to blue mold, and reduced quality in the case of flue-cured tobacco, have limited the usefulness of this source. A type 54 cigar binder tobacco, Havana 307, has been shown to be tolerant to all known severe strains of PVY in the U.S., and has also exhibited tolerance to tobacco etch virus (TEV) and tobacco vein mottling virus (TVMV). Efforts to utilize this alternate source of resistance to PVY are underway. Thirty anther-derived doubled haploid lines from an original population of 289 were identified in greenhouse tests in 1986 as tolerant or similar to Havana 307 in their reaction to PVY. This past year these 30 lines were retested for their reaction to severe strains of both PVY and TEV. A sample of the results are presented in Table 1. These 30 lines were also grown under virus-free field conditions to evaluate their agronomic and flue-cured characteristics.

Levels of resistance equal to Havana 307 for both PVY and TEV were recovered in the doubled haploid lines tested. Field evaluations indicated; however, that these doubled haploid lines displayed flue-cured characters in varying degrees and additional backcrossing is necessary before this material would be useful in a flue-cured breeding program.

B. Development of Insect Resistant Germplasm.

Efforts are underway to develop flue-cured germplasm with resistance to tobacco budworms using TI 1112 as a source. This TI is characterized by its glandless trichome trait. Over the past four years we have been screening a large doubled haploid population for resistance to the budworm under natural field infestation. Because of variability of such tests we rescreened all lines identified with resistance in 1987. Most lines are generally of poor quality and closely resemble the resistant parent. Resistant selections were made and backcrosses made. A second cycle of maternal doubled haploids are being produced.

C. Isozyme Studies.

Attempts are being made to identify genetic variability (segregating loci) among isozymes of tobacco and utilize these loci as genetic markers in tobacco and the Nicotiana species. There is little demonstrated intraspecific variation of isozyme patterns in N. tabacum. We have found differences in the alcohol dehydrogenase (ADH) isozyme pattern among the various recognized tobacco cultivar types (burley, flue-cured, etc.). Segregation and cosegregation patterns of crosses between variant types, as well as patterns of progenitor species, N. sylvestris and N. tomentosiformis and a synthetic allotetraploid between these species were used to determine the inheritance of ADH in tobacco. The progenitor species are each characterized by a single band of activity with different electrophoretic mobilities. The synthetic allotetraploid exhibits a three-band pattern, two bands which comigrate with the progenitor species and an intermediate band. Tobacco cultivars exhibit either a single isozyme band which comigrates with N. sylvestris or a three-band pattern identical to the synthetic allotetraploid. Results confirm the dimeric nature of ADH in tobacco and the involvement of two loci in controlling expression.

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Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

II. Graduate Students: none

III. Postdoctoral Fellows: none

IV. Manuscripts in Review:

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VII. Papers Presented at Professional Meetings:

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Severson, R. F., R. F. Arrendale, H. C. Cutler, D. Jones, V. A. Sisson and M. G. Stephenson. 1987. The chemistry and biological activity of acylated nornicotines from Nicotiana repandae. American Chemical Society Meeting. New Orleans, LA Aug. 30 - Sept. 4. (presentation)

Severson, R. F., R. F. Arrendale, V. A. Sisson, and M. G. Stephenson. 1987. Isolation and characterization of the cuticular sugar esters of Nicotiana kawakamii. 41th Tobacco Chemists' Research Conference. Greensboro, NC. October 4-7 Vol. 41, p. 19. (abstract)

Sisson, V. A. 1987. "Maintenance, evaluation and utilization of the Nicotiana species." Presented April 2, 1987 at the Tobacco Staff Meeting, N. C. State University, Raleigh, NC. (presentation)

Sisson, V. A. 1987. A Curator's Interaction with the National Plant Germplasm System. Presented to the International Plant Germplasm Workshop sponsored by IBPGR and N. C. State University, August 2-22, 1987. Raleigh, NC. (presentation)

Sisson, V. A. 1987. Genetic control of alcohol dehydrogenase isozymes in Nicotiana tabacum. 1987 Agronomy Abstracts. p. 79. (abstract)

Snook, M. E., W. S. Schlotzhauer, O. T. Chortyk, G. R. Gwynn and V. A. Sisson. 1987. The development and significance of polyphenols in tobacco leaf and flowers and their relationship to cigarette smoking. 193rd National Meeting of the American Chemical Society, Denver, CO. Apr. 5-10. (presentation)

Snook, M. E., O. T. Chortyk, R. F. Arrendale, V. A. Sisson and D. M. Jackson. 1987. Interesting polyphenol constituents in the flowers of the Nicotiana species. 41st Tobacco Chemists' Research Conference Greensboro, NC. Oct. 4-7. Vol. 41, p. 33. (abstract)

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IX. Acknowledgments:

I would like to acknowledge the cooperative efforts of R. F. Arrendale, J. F. Chaplin, G. V. Gooding, D. M. Jackson, R. F. Severson, M. G. Stephenson, M. E. Snook and R. E. Williamson. In addition, I would like to acknowledge the excellent technical assistance of E. T. Woodlief, W. H. West, A. Morgan and W. Parrot and the statistical and clerical assistance of E. H. Brummitt.

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Title: Cellular and Molecular Approaches to Tobacco Improvement

Project Leader: S. M. Reed

I. Summary of Research:

DNA amplification in dihaploid populations of N. tabacum has been investigated. Amount of DNA in two flue-cured cultivars, NC95 and Coker 139, and dihaploid populations derived from these cultivars was measured using a flow cytofluorometric procedure. Nuclei were isolated, stained with the DNA-specific fluorochrome propidium iodide, and analyzed on a Becton Dickinson FACS 440. Chicken erthyrocytes, which were included in each sample, served as an internal standard. Results of two years data are presented in Table 1. Data is presented as relative amount of DNA, which was calculated by dividing mean fluorescence of the tobacco nuclei by the mean fluorescence of the internal standard.

Table I

Line[1]	Relative amt. DNA[2]
C139	9.8 e
C139 DHH	11.4 bc
C139 SC DHH-9A	11.5 bc
C139 SC DHH-7	11.0 cd
C139 DHL	12.4 ab
C139 SC DHL-5	12.6 a
C139 SC DHL-1	11.2 cd
NC95	9.8 e
NC95 DHH	10.3 de
NC95 SC DHH-3	10.2 de
NC95 SC DHH-7	10.2 de
NC95 DHL	11.5 bc
NC95 SC DHL-2	10.2 de
NC95 SC DHL-6	10.9 cd

[1]DHH = high yielding dihaploid
DHL = low yielding dihaploid
SC = second cycle

[2]Data averaged over 2 years; 4 replications/year.

Values followed by different letters are significantly different at the .05 level.

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Analysis of combined 1986 and 1987 data showed highly significant differences due to replications (P=.0019) and to lines (P=.0001). Year, entry x rep, rep x year, and entry x year effects were not significant. Within the C139 entries, the maximum increase in DNA that was observed was 28%, which was found in a low yielding second cycle dihaploid (C139 SC DHL-5). All C139-derived dihaploids has significantly more DNA than did C139. Differences in amount of DNA were less dramatic between the NC95 entries. The maximum increase in DNA observed among the NC95 dihaploids was 17%, which was found in a low yielding first cycle dihaploid. This and one other line, a low yielding second cycle dihaploid, were the only two NC95 entries that had significantly more DNA than did their source cultivar.

Low-yielding second cycle dihaploids have been backcrossed to their source cultivars, and the progeny examined cytologically. While the majority of somatic cells in these backcross progeny have 2N=48 chromosomes, several chromosome deficient cells have been observed with some cells having as few as 10 chromosomes. Chromosome elimination appears to be a result of malfunctioning spindles. Meiotic irregularities, such as multivalents and eliminated chromatin, have also been observed. It is possible that these cytological irregularities are caused by different amounts of DNA in the two parental genomes.

IV. Publications:

Reed, S. M. and J. A. Burns. 1987. The nucleolus organizer chromosomes of Nicotiana tabacum L. J. Hered. 78:400-401.

Kramer, M. G. and S. M. Reed. 1988. An evaluation of maternal nullihaploidy for the production of nullisomics of Nicotiana tabacum L. I. An interspecific hybridization approach. J. Hered.

V. Manuscripts Accepted for Publication:

Reed, S. M. In vitro conservation of germplasm. In Proceedings of the International Germplasm Workshop, Raleigh, NC, August 2-22, 1987.

Reed, S. M., E. A. Wernsman, J. A. Burns, and M. G. Kramer. An evaluation of the use of irradiated pollen for gene transfer in Nicotiana. Plant Sci. (in press).

Kramer, M. G. and S. M. Reed. An evaluation of maternal nullihaploidy for the production of nullisomics of Nicotiana tabacum L. II. A pollen irradiation and ovule culture appraoch. J. Hered. (in press).

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VI. Manuscripts in Review:

Reed, S. M., J. A. Burns, and E. A. Wernsman. Cytological observation of the heterochromatin of Nicotiana tabacum L. androgenic doubled haploids.

Jenn, A. E., M. E. Daub, and S. M. Reed. Limitation of the Su albino gene marker system in fusions between Nicotiana repanda and Nicotiana tabacum.

VII. Papers Presented at Professional Meetings:

Reed, S. M. An evaluation of the stability of Nicotiana tabacum genetic markers during callus culture and regeneration. American Society of Agronomy Annual Meetings, Atlanta, GA. Nov.29-Dec. 4, 1987.

Title: Varietal

Project Leader:

I. Summary of

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IX. Acknowledg

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Title: Varietal Evaluation Studies in Burley Tobacco

Project Leader: Daryl Bowman

I. Summary of Research

A. N. C. Official Variety Test - Burley Tobacco (1987)

Twelve released varieties and three experimental lines were tested at two locations. VA 509 and KY 14 were included as standards in these tests. New varietal releases such as TN 86 and VA 510 were included. The experimental lines were from Dr. R. C. Rufty's program.

In the future this information will be available through a research report. Currently this information is being disseminated through the Burley Tobacco Information bulletin.

B. Regional Minimum Standards Program

The first phase of the Regional Minimum Standards Program consists of the Regional Small Plot Tests one of which is located at the Mountain Research Station in Waynesville. In 1987 there were 13 entries.

The Regional On-Farm Test is the final phase of the program and two tests are located in North Carolina. Four entries were in the test in 1987 two of which were the checks, VA 509 and KY 14.

II. MS Graduate Student

Terry Kelley

IX. Acknowledgments

This program is conducted by Carroll M. Sasscer, Jr., burley researcher, at the Mountain Research Station.

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Title: Varietal Evaluation Studies in Flue-Cured Tobacco

Project Leader: Daryl Bowman

I. Summary of Research:

A. N. C. Official Variety Test - Flue-Cured Tobacco (1987)

Twenty-four released varieties and 20 experimental lines were tested at five locations. NC 95 and NC 2326 were included as standards in these tests.

Up-to-date information is available on the performance of these varieties in the results of the North Carolina Official Variety Research Report No. 111, dated December 1987 from experiments conducted in 1987. The test locations represent growing conditions in the Border, Eastern, Middle and Old Belts in North Carolina. Research Report No. 111 serves as a guide in helping growers choose their 1988 varieties for planting. Copies of this report are mailed to county extension chairmen, seedsmen, and agri-business representatives.

B. Regional Minimum Standards Program

The first phase of the Regional Minimum Standards Program consists of the Regional Small Plot Tests which are located on tobacco experiment stations in the flue-cured region. In North Carolina the tests are located at the Border Belt Tobacco Research Station, Lower Coastal Plain Tobacco Research Station and the Oxford Tobacco Research Station.

In 1987, thirty-three entries were included in the Regional Small Plot Test, along with the two standards--NC 2326 and NC 95. A separate publication giving individual location data and combined data for five locations has been distributed to all committee members and other interested parties. Ten lines met the minimum standards in the Regional Small Plot Test and may be advanced to the Regional Farm Test in 1988.

The Regional Farm Test is the final phase of the Regional Minimum Standards Program and in 1987 contained seven lines which were evaluated under code by the Variety Evaluation Subcommittee of the Flue-Cured Tobacco Quality Committee. Three met the minimum standards. The lines were NC TG-37, NC 4027 USDA, and NK 5168. These have been evaluated for two years in the Regonal Small Plot Test and one year in the Regional Farm Test and have met the standards as prescribed. This makes 92 entries that have met the minimum standards since this program was developed. Seed of these three lines may be available for 1989 plantings should the breeder or agency decide to increase the seed. Data from the Regional Far

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Test are published annually in the Flue-Cured Tobacco Variety Evaluation Committee Report.

II. MS Graduate Student

Terry Kelley

IV. Publications

Bowman, D. T., W. T. Kelley, and G. Tart. "Measured Crop Performance Tobacco 1987." Research Report No. 111, December 1987.

Bowman, D. T., T. C. Corbin, and A. G. Tart. 1986. Unbiased sampling from tobacco warehouse displays. Tob. Sci. 30:163-164.

VI. Manuscripts in Review

Bowman, D. T., A. G. Tart, E. A. Wernsman, and T. C. Corbin. Revised North Carolina grade index for flue-cured tobacco. Tob. Sci. (In Review).

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Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

Title: NCO-3774, "Effective and Efficient Weed Management Programs for Corn, Tobacco, Small Grains and Sorghum."
and
NCO-3569, "Vegetation Control in No-Tillage Crop Production."

Project Leader: A. D. Worsham, Crop Science Department

Abstract: Imazaquin (Scepter), clomazone (Command), and cinmethylin (Cinch) continued to give very good weed control in tobacco when applied immediately after transplanting. One new herbicide, lactofen (Cobra) appeared promising when applied to the soil surface before transplanting. Scepter plus Command continued to give the best weed control. Treatments of Scepter, Scepter plus Command and Cobra gave varying degrees of early-season stunting to the crop. Clothodim (Select) gave good annual grass control when applied after transplanting or postemergence over-top to tobacco and grass. Napropamid (Devrinol) mixed with dry fertilizer and incorporated gave as good as or better weed control than applying the herbicide alone in burley tobacco. Devrinol, Enide, Prowl, and Paarlan gave good weed control in a number of on-farm tests. Prowl and Paarlan did not give good control of hairy galinsoga or ragweed. NF 28 continued to give high no-till yields. Good tobacco again was grown in killed legume cover crops with yields being generally higher than that for rye cover. Quality, however, was lower for the legumes. Yields of no-till burley tobacco were very good as were results for two on-farm no-till burley tests. Slugs destroyed a no-till burley test at the Upper Mountain Research Station. In no-till burley tobacco, a killed abruzzi rye mulch appeared to give better weed control than a new variety, SS2. Charcoal applied in the transplant water gave protection from Scepter injury. Eight lb/A of charcoal was better than 2 or 4 lb/A. The higher the rate of water, the more protection charcoal gave from Scepter injury. Seven herbicides; AAtrex, Classic, Scepter, high rates of Tillam and Prowl, dicamba and Cobra were evaluated for the degree of charcoal protection. Significant protection from Scepter, Classic and AAtrex was obtained with some protection from Dicamba. Cobra did not injure the tobacco. Use of charcoal in the transplant water stimulated early growth of tobacco.

[1]In cooperation with Robert L. Davis, Assoc. Ext. Prof. (Burley tobacco), Mt. Res. Sta., Waynesville, N.C.; Fred Yelverton, Ext. Tobacco Specialist, N.C.S.U.; Tom Wiepke, Grad. Res. Assist.; and technical assistance from Richard Lemons, Res. Technician.

1. Summary of Resear

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1. Summary of Research (Tests in Group 1): Project NCO-3374

1. General Experimental Methods: Fifteen types of experiments were conducted in the field in 1987. This research will be separated into three major groups. The first group (Group 1) consists of several different tests involving herbicide evaluations in conventional flue-cured and conventional burley tobacco. The second group (Group 2) consists of several experiments related to the production of no-till flue-cured tobacco and no-till burley tobacco. The third group (Group 3) consists of several experiments related to the use of powdered charcoal used in transplant water as a protectant from possible herbicide injury on tobacco.

The following are the subtitles given to the experiments in Group 1: (A) Herbicide Evaluation in Flue-cured Tobacco , (B) Pre-Postemerence Herbicide Evaluation for Grass Control in Tobacco, (C) The Evaluation of Devrinol Impregnated on Fertilizer in Burley Tobacco, and (D) Burley On-Farm Weed Control Tests.

The tests in Group 1 were conducted at the following research stations: the Lower Coastal Plains Research Station near Kinston, the Upper Piedmont Research Station near Reidsville, the Mountain Research Station near Waynesville, and the Upper Mountain Research Station near Laurel Springs. On-farm tests were conducted in several counties in the burley area of Western North Carolina.

Product description, including chemical names, common names and manufacturers of compounds used in 1987 are given in Table 1. Other detailed information (such as soil description, tobacco varieties, and treatment dates) is included in the narrative with each test. These narrative data tables are in the Appendix, along with weather data (Appendix Tables 1-21).
A WSSA approved list of computer codes for weeds reported in this research is given in table 2.

Herbicide treatments were applied broadcast with a CO_2 pressurized backpack sprayer having five whirl-chamber nozzles on a boom at 20-inch spacings. The sprayer was operated at 3 mph and 20 psi to deliver 19.1 gal/A. For incorporated treatments, herbicides were disked in immediately after application with a tandem disc harrow set to cut 4 to 6 inches deep and operated at 4 mph. Two length-wise trips were made down and back in each plot with the disc. In the surface-applied treatments, all beds were first knocked off to obtain an 8 to 10 inch flat bed top and herbicides were applied broadcast before transplanting. The overtop treatments were applied to the plots immediately after transplanting. Any variations in these methods are given in specific methods for each test.

The tobacco was grown according to standard practices and was harvested and cured by flue-cured or burley methods. All tobacco on the research stations was irrigated as needed except at the Kinston and Laurel Springs locations. An official grader rated the tobacco by plot by priming. Some tests were analyzed for certain chemical constituents in the Crop Science Department tobacco chemistry laboratory.

All in-field ratings of experiment plots were made independently each time by two persons and these values were averaged to obtain a rating for a particular plot. Weed control ratings are based on a 0 to 99 scale: 0 = no

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control and 0 = perfect control. Injury ratings are based mainly on stunting of tobacco plants unless otherwise specified (0 = no injury, 99 = crop kill).

Rainfall and irrigation data for the tobacco research locations are given in Appendix Tables 1 through 8.

A. Herbicide Evaluation Test in Flue-cured Tobacco. The herbicides are listed in Tables 3 to 6. A randomized complete block design with 4 replications each was used at both the Kinston and Reidsville locations. Both tests received two cultivations during the growing season.

Weed control and injury ratings were taken throughout the growing season. Weed control ratings at Kinston were based on DIGSA <1 /sq.ft. and CHEAL <1 /sq.ft.. At the Reidsville location weeds present were DIGSA 1-3 /sq.ft. and AMARE 1-3 /sq.ft.. At both locations injury ratings were on percent stunting (0 = no injury and 99 = crop kill).

Results: At Kinston, with low weed populations, all herbicides gave excellent control of DIGSA and CHEAL throughout the growing season (Table 3). Scepter at .095 #ai./A OT gave heavy early season stunting. Cobra at 1.0 #ai./A and both treatments of Scepter plus Command gave moderate early season stunting but there was no stunting observed at the end of the season.

Yield, grade index, % sugar, and % total alkaloid showed no significant differences among treatments (Table 4).

At Reidsville all herbicides gave excellent early season control of DIGSA and AMARE. With two cultivations, all treatments gave very good to excellent control for the entire season (Table 5). With dry weather, tobacco growth was very irregular in the early season and difficult to evaluate for stunting. But, by late season, with better growing conditions, uniformity was much improved. In mid-August, heavy stunting was observed with Scepter at .095 #ai/A. OT and stunting with Scepter rate of .06 #ai/A..

Because of poor growing conditions yields were poor for all treatments. There were no meaningful differences in yield, grade index, or chemical constituents among treatments (Table 6).

B. Pre-Postemergence Herbicide Evaluation for Grass Control in Tobacco. Herbicides are listed in Table 7 . A randomized complete block design with 4 replications was used at the Reidsville location. All plots were cultivated twice during the growing season.

Weed control ratings were based on DIGSA <1/sq.ft. at both rating dates. Injury ratings were based on 0 = no injury and 99 = crop kill.

Results: Both rates of Select OT and POT gave excellent DIGSA control throughout the season with no injury to the tobacco observed.

There were no significant differences in yield, grade index, and chemical constituents among the treatments (Table 7).

C. The Evaluation Of Devrinol Impregnated On Fertilizer In Burley Tobacco. Herbicides are listed in Tables 8 and 9. A randomized complete block design

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with four replications each was used at the Waynesville and Laurel Springs locations. The objectives of these tests were to determine if Devrinol could be impregnated on granular fertilizer and incorporated to achieve the same weed control as Devrinol applied broadcast then incorporated. Fertilizer analysis for Waynesville was 8-8-8 and for Laural Springs 5-10-15. Devrinol 4F at 1.0 and 2.0 #ai./A was impregnated on fertilizer by mixing the amount of active ingredient with 100 ml. of water while thoroughly mixing with the amount of fertilizer to be applied to each plot. The mixture was then left to dry for approximately one hour then broadcast by hand for the appropriate treatment. In all other plots the correct amount of fertilizer was also broadcast by hand. All plots were double-disked incorporated 2 in. in depth.

Weed control and injury ratings were taken were taken in early season. After cultivations all plots remained clean for the entire season at both locations. Weed control ratings at Waynesville were based on DIGSA 1-3/sq.ft., GASDI <1 /sq.ft., and CHEAL <1 /sq.ft.. At Laurel Springs, weeds present were AMARE 1 /sq.ft., POROL 1-3 /sq.ft., PANDI 1 /sq.ft., and MOLVE 1-3 /sq.ft.. AT both locations, injury was based on percent stunting (0 = no stunting and 99 = crop kill.

Results: There were no significant differences in weed control among the Devrinol treatments at either location (Tables 8 and 9). All treatments gave very good to excellent control of all weed species compared to the cultivated check. At the Laural Springs location, there was a trend for Devrinol impregnated on fertilizer to give better weed control than Devrinol alone. There was some slight stunting with Devrinol at 2.0 #ai./A impregnated at the Waynesville location in early season but by mid-season none was observed. No stunting was observed at the Laurel Springs location.

Devrinol at 2.0 #ai./A gave a higher yield than the cultivated check. Other treatments had yields between these two treatments.

D. Burley On-Farm Weed Control Test. Herbicides used are listed in Table 10 . Eight locations were selected in Western North Carolina to evaluate herbicides for weed control in burley tobacco. A randomized complete block design with three replications each was used for each test. Each test received the same herbicide treatments.

The average percent weed control and the number of locations in which each weed species occurred are given in Table 10.

Results: Devrinol 4F, Devrinol 50WP at 1.0 #ai./A and Enide at 6.0 #ai./a applied over top after transplanting gave very good to excellent control of all weed species. Prowl at 1.0 #ai./A applied preplant incorporated gave good to excellent control of all species except hairy galinsoga which was poor. Paarlan at 1.0 #ai./A applied preplant incorporated gave good to excellent control of all species except hairy galinsoga and goosegrass which were poor. Ragweed control with Prowl and Paarlan was not as good as compared to the treatments of Devrinol and Enide.

Summary of Research (Tests in Group 2): Project NCO-3569

1. General Experimental Methods: The second group of experiments were designed to evaluate several aspects of growing no-till tobacco. Included were tests to study variety evaluation, weed control, legume-rye as cover crops, and rye

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variety cover crop influence in no-till tobacco. Land was prepared, soil treatments (soil insecticide/nematicide or multipurpose fumigant, depending on location) were applied , and land was bedded in the fall for no-till tobacco. A cover was sown and seeds were covered with a rolling cultivator adjusted to fit the beds or left flat when land wasn't bedded. Approximately two weeks before transplanting, cover crops were killed with Gramoxone at .56 #ai./A applied overtop. Tobacco was transplanted using a commercially available no-till one-row transplanter. The transplanter was equipped with a double-disk opener, wide rubber-tire press wheels, and a new modified drive mechanism consisting of a wide rubber drive wheel in front of the disk opener. A coulter in front of the drive wheel was used where mulch was heavy. Tobacco was fertilizer by side-dressing with 40# N -40# P2O5 -120# (K2O) at planting and 25 units of N were applied as a surface sidedressing later in the season. Variations from these methods in some tests are noted.

All background information is included in the narrative reports from each test (Appendix Tables 9 through 21). Any variations in methods are given in specific descriptions of each test.

The tests will be referred to as (E) No-Till Tobacco Variety Evaluation (F) Rye Variety Influence For No-Till Flue-Cured Tobacco (G) Legume, Legume and Rye Mixture Cover Crops for No-till Flue Cured Tobacco (H) No-Till vs. Conventional Burley Tobacco Herbicide Evaluation (I) Rye Variety Influence For No-Till Burley Tobacco and (J) On-Farm Evaluation Of No-Till Burley Tobacco. These tests were conducted at the following locations: the Central Crops Research Station near Clayton, the Upper Coastal Plains Research Station near Rocky Mount, and the Upper Mountain Research Station near Laurel Springs. The two on-farm no-till burley tests were located in Mitchell Co. and Buncombe Co..

E. No-Till Tobacco Variety Evaluation. Yields, grade index, and chemical constituents are listed in Table 11. The objective of this test was to determine if increased yields in no-till tobacco could be obtained by using different varieties and to compare performance among several varieties under no-till conditions. A randomized complete block design with 8 replications was used at the Clayton location. Plot size was one row by 42 ft. with a final stand of 20 plants per plot. Tobacco varieties used were K 326, NF 28, C 319, NF 22, G 70, NC 82, and M 373.

Results: Yields were not significantly different among varieties at the .05 confidence level, but as in recent years NF 28 had the higher yield. It was significantly higher than all other varieties at the 10% confidence level. There were no significant differences in grade index or chemical constituents.

F. Rye Variety Influence For No-Till Flue-Cured Tobacco. Herbicides used, yields, grade index, and chemical constituents are listed in Table 12. A randomized complete block design with 4 replications was used at the Clayton location. The objective of this test was to determine if rye variety could influence the growth of no-till tobacco. The two varieties chosen were Abruzzi (a tall-growing variety) and SS2 (a short-growing variety). Also different herbicide treatments were added to observe possible differences in weed control.

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ineffectiveness of the herbicides used for yellow nutsedge control, additional treatments of herbicides were used to prevent yield loss and possible test loss. The herbicide, Ignite was directed to the row middles at the rate of 1.0 #ai./A on the entire test with a shielded sprayer. The test stayed weed free for the entire season and therefore no weed control data were obtained. There were no significant differences between yield, grade index and chemical constituents. However, there was a trend of higher yields in the plots with Abruzzi rye. No visual differences in growth were observed during the season.

G. Legume, Legume and Rye Mixture Cover Crops for No-till Flue Cured Tobacco. Field experiments were established at Central Crops Research Station and the Upper Coastal Plain Research Station in the fall of 1986 to continue the evaluation of legume, legume and rye mixture cover crops for no-till flue-cured tobacco. The experimental design at both locations was a RCB split-plot, with the main plots consisting of the different cover crop treatments; and the sub-plot treatments were nitrogen at sidedressing and no nitrogen at sidedressing.

Results: Cover crops were well established at both locations by April, 1987. The main plots with hairy vetch alone or in a mixture, again required more than one application of paraquat. No significant stand reduction or reduced vigor of tobacco transplants was observed as in the previous year.

Yield of no-till tobacco at the Central Crops Res. Station in 1987 was excellent and of acceptable to good quality. Tobacco planted into crimson clover, hairy vetch and the hairy vetch-rye mixture yielded significantly higher than conventional (cultivated) tobacco(Table 13). However, grade index values for the highest yielding cover crop treatments, crimson clover and hairy vetch, were significantly lower than the other treatments (Table 15). Leaf chemical constituents were also affected by cover crop. Percent sugar was significantly lower in tobacco grown in the crimson clover and hairy vetch cover crops (Table 13). Tobacco grown in legume or legume-rye mixture cover crops without sidedress nitrogen application did not yield significantly different from tobacco that received 22 kg N/ha at sidedress (Table 15).

Yields were low again at the Upper Coastal Plain Res. Station in 1987, but quality was higher than last year. Yield of no-till tobacco in legume or legume-rye mixture cover crops averaged 30% lower than conventional (cultivated) tobacco(Table 14). There were no significant differences in grade index, % sugar or % total alkaloids among treatments.

H. No-Till Vs. Conventional Burley Tobacco Herbicide Evaluation. Herbicides are listed in Table 16. A randomized split block design with 4 replications was used at the Laurel Springs location. Abruzzi rye was used for the no-till cover crop and was planted in the fall of 1986. Gramoxone at .56 #ai./A was applied approximately two weeks before transplanting and 100% rye kill was obtained by transplanting time. Base fertilizer was broadcast over the field at the rate of 1,400 lbs. 8-8-8/A 10 days before transplanting. Tobacco was transplanted and a very good stand was established in both the no-till and conventional blocks. The conventional plots were cultivated twice during the growing season.

After the first week, slugs were observed in the no-till block feeding on the tobacco. Slug baits were then placed in the field for control. However, because of rainy conditions the bait was not effective. The process was

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repeated daily for 3-4 days but rainy weather persisted and within one week 95% of the plants were destroyed. Tobacco was reset when dry weather permitted, approximately 2 weeks later but it didn't grow because of late planting followed by hot and dry weather. Therefore only weed control data are presented for the no-till treatments.

Weed control and injury ratings were taken through mid-season , then the no-till block was abandoned because of poor tobacco growth. Yields were obtained in the conventional plots to check for herbicide differences in yields.

Weed control ratings were based on AMARE 1-3 /sq.ft., POROL 1-3 /sq.ft., and MOLVE <1 /sq.ft.. Injury ratings were based on stunting (0 = no injury and 99 = crop kill).

Results: All no-till herbicide treatments gave excellent control of all weeds present in early season (Table 16). All no-till treatments gave better weed control than did the same treatments in conventional plots. Note the excellent control in the Gramoxone only check compared to the conventional check in early season suggesting high weed suppression from allelopathic chemicals in the rye mulch, lack of soil disturbance, or both as has been reported in previous no-till tobacco research. After the first cultivation, all conventional treatments had very good to excellent weed control for the entire season. No significant crop injury was observed. Yields among the herbicide treatments were not signif-icantly different. Yield of the cultivated check plots, however, averaged much less than for the herbicide treatments.

I. Rye Variety Influence For No-Till Burley Tobacco. Herbicide used, weed control, yields, and grade index are listed in tables 17, 18, and 19. A randomized split block design with four replications was used at the Waynesville location. The whole blocks were two rye varieties and conventional block. The sub-plots were herbicide treatments. The two rye varieties used were Abruzzi (a tall growth variety) and SS2 (a short growth variety). The objective of this test was to determine if rye varieties could influence weed control and growth in no-till burley tobacco.

The Abruzzi rye was flattened by a mid April snow fall, but the SS2 variety remained standing. Gramoxone at .56 #ai./A was used to kill the rye approximately two weeks before transplanting.

Weed control and injury ratings were taken throughout the growing season. Weed control ratings were based on CHEAL 1-3/sq.ft., ELEIN <1/sq.ft., DIGSA 1/sq.ft. and AMARE 1-3/ sq.ft.. Injury ratings were based on percent stunting (0= no injury and 99= complete kill).

Results: The transplanting method for the no-till tobacco went extremely well, even with the Abruzzi rye flattened. A analysis of variance T Test (LSD .05) for a randomized split block design was used for statistical analysis of results.

At the 7/8 rating date there was a significant interaction between mulch and herbicide treatments for all weeds rated. Mulch and herbicide treatments were also significant. There was also significantly greater weed control in the two rye blocks compared to the conventional check with all 7/8 weed

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ratings. The control of ELEIN and DIGSA at the early rating were significantly higher with Abruzzi rye compared to SS2 variety in the Gramoxone check. Both Devrinol and Enide gave significantly better control of CHEAL and AMARE in the two rye varieties than in the conventional tobacco at the early rating date. DIGSA and ELEIN control in the Abruzzi rye with Scepter was significantly higher than with Scepter in the conventional tobacco.

At the late rating, 8-20-87, Enide gave better control of CHEAL in both rye cover crops compared to the conventional Enide treatment. There was also a significant difference in the control of CHEAL between each whole block checks.

There was no significant mulch/herbicide interaction at the early rating (7-8-87), but significant differences between mulch and herbicide treatments were obtained. Abruzzi rye CRINJ rating was significantly greater than SS2 rye. Also on the early rating date, herbicide treatments of Scepter and Scepter plus Command gave significantly greater CRINJ than in all other treatments.

There were no significant mulch/herbicide interactions in yield between the two ryes or the conventional treatment. However, Scepter at .095 Lb.a.i./A applied OT significantly reduced yields in both of the two no-till and the conventional whole blocks due to crop injury. Weed competition significantly reduced yields in each of the whole block checks.

J. On-Farm Evaluation Of No-Till Burley Tobacco. Yields and values are listed in Table 20. Two split block nonreplicated demonstrations were evaluated in two Western North Carolina counties (Mitchell and Buncombe). Each location contained .10 acre block of no-till and .10 acre block of conventional burley tobacco. Each block was harvested and graded according to standard burley practices.

Both locations received the following herbicide treatments. Gramoxone at .56 #ai./A was applied for cover kill on the no-till then Devrinol at 1.0 #ai./A was applied over top after transplanting on both blocks. The no-till was kept clean by hand weeding and the conventional by cultivation when needed during the growing season. Weed control was not very good from Devrinol in the conventional block because of drought, and extra cultivations and hand weeding had to be done. Slugs appeared in the no-till at both locations. Slug pellets were placed in and around both fields and were very effective.

Results: At the Mitchell Co. location tobacco was transplanted into a field with fescue sod that had been out of production for several years. Soil conditions were very moist and transplanting went better than expected. In dry conditions transplanting might be difficult in this type sod situation.

This test site was extremely dry for the entire season and growth in the no-till block was visibly superior to the conventional block for the entire season. Yields, dollars/A, and dollars/CWT were almost double in the no-till vs. the conventional blocks (Table 20).

We feel moisture retention in the fescue sod contributed to these results plus there was some weed infestation at times in the conventional tobacco.

At the Buncombe Co. location tobacco was transplanted into a rye cover that was planted the previous fall. At this location moisture conditions were

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moderate for the season and no visible differences were observed during the season. There were no yield, dollar/A, or dollar/CWT differences between no-till and the conventional. Weed control was generally better in the no-till and conventional tobacco at this location as compared to the Mitchell Co. location.

Summary of Research (Tests in Group 3):

1. General Experimental Methods: The third group of experiments were designed to study the use of powdered charcoal as a protectant against herbicide injury on tobacco.

The following are subtitles given to the experiments in Group 3: (K) Charcoal as a Protectant From Herbicide Injury in Tobacco, (L) Incorporated Herbicide Evaluation With Charcoal As A Protectant in Tobacco, (M) Charcoal Rate Evaluations in Tobacco, (N) Charcoal Water Rate Evaluation in Tobacco, and (O) Herbicide Screening For Possible Protection with Charcoal in Tobacco.

The tests in Group 3 were conducted at the following research stations: the Upper coastal Plain Research Station near Rocky Mount, the Lower Coastal Plain Research Station near Kinston, the Central Crops Research Station near Clayton, and the Upper Piedmont Research Station near Reidsville.

Product description, including chemical names, common names and manufacturers of compounds used in 1987 are given in Table 1. Other detailed information (such as soil description, tobacco varieties, and treatment dates) is included in the narrative with each test. These narrative data tables are in the Appendix, along with weather data (Appendix Tables 1-21). A WSSA approved list of computer codes for weeds reported in this research is given in Table 2.

Herbicide treatments were applied broadcast with a CO_2 pressurized backpack sprayer having five whirl-chamber nozzles on a boom at 20-inch spacing. The sprayer was operated at 3 mph and 20 psi to deliver 19.1 gal/A. For incorporated treatments, herbicides were disked in immediately after application with a tandem disc harrow set to cut 4 to 6 inches deep and operated at 4 mph. Two length-wise trips were made down and back in each plot with the disc. The overtop treatments were applied to the plots immediately after transplanting. Any variations in these methods will be given in specific methods for each test.

K. Charcoal as a Protectant from Herbicide Injury to Tobacco. A randomized complete block design with four replications each was used at the Kinston and Reidsville locations. The objective of this study was to determine what method of using charcoal was more effective (charcoal in the transplant water vs. root dip in charcoal slurry). For the transplant water treatments, charcoal was mixed with the transplant water at the rate of 8#/A. 100 ml. of X-77 surfactant was added to each 55 gal. tank of transplant water to help keep charcoal in suspension. The transplant water rate for this test was 225 gal./A. For the charcoal root-dip slurry, 1# of charcoal per 1.5 gal. of water plus 100 ml. of X-77 surfactant was mixed throughly and plants dipped into the slurry then immediately transplanted. All herbicide treatments were applied overtop after transplanting in this test.

Results: At the Kinston location tobacco stunting was moderate to heavy with Scepter at .25 and .50 #ai./A. OT in early season (Table 21). The only

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charcoal treatment that gave significant protection was with Scepter at .25 #ai./A OT with charcoal in the transplant water. This was the only treatment where the yields were not reduced because of herbicide injury when compared to the cultivated checks. There were some differences in grade index, but they did not seen to follow any pattern that was related to treatment. % sugar was lower in the .50 #ai./A of Scepter with charcoal root dip.

At the Reidsville location tobacco stunting was very heavy with both rates of Scepter through mid-season. A decision was made not to take cured yields on this test. A green leaf weight was taken by harvesting the leaves from 5 plants per plot. Both treatments with charcoal in the transplant water significantly reduced stunting compared to root-dip and no charcoal treatments. At this location we saw an adverse effect with the root-dip treatments. This might be explained because of soil loss from the roots during the dipping procedure. Better growth was noted in the cultivated check with charcoal in the transplant water but no difference in yields was obtained. The high rate of Scepter .50 #ai./A OT did significantly reduce yields in the root-dip and the no charcoal treatments compared to the Char-tpw and the cultivated checks.

L. Incorporated Herbicide Evaluation With Charcoal As A Protectant In Tobacco. Herbicides are listed in Table 23. A randomized complete block design with four replications was used at the Reidsville location. The objective of this test was to determine what amount of protection could be obtained from using charcoal in the transplant water with herbicide treatments of Prowl, Scepter, and Squadron (a premix of Prowl and Scepter) incorporated into the soil before transplanting. The .862 #ai./A of Squadron is equal to .125 #ai./A of Scepter and .75 #ai./A of Prowl. Charcoal was used in the transplant water at the rate of 8 # /A. X-77 surfactant was added at the rate of 100 ml. per 55 gal. of water and the transplant water rate was 225 gal./A.. Herbicide stunting was severe at this location and a decision was made not to harvest for the cured leaf weights. However, we did harvest the green leaf weights from 5 plants per plot.

Results: Charcoal transplant water treatments did give significant protection with the Scepter and Squadron herbicide treatments (Table 23) . There also was a trend for protection when Prowl was used but it wasn't significant. All charcoal herbicide treatments gave increased yields when compared to the herbicide treatments with no charcoal. The reason for the yield difference between the charcoal-no charcoal checks is not clear because the charcoal check was visibly more uniform during the growing season.

M. Charcoal Rate Evaluation in Tobacco. This test was initiated to determine the optimum rate of charcoal to successfully protect tobacco from phytotoxic effects from Scepter. Three rates of Scepter (0, 0.28, and 0.57 kg ai/ha) applied PRE with four rates of charcoal applied in the transplant water (0, 2.24, 4.48, and 8.96 kg/ha). This was also arranged in a split plot statistical arrangement at two locations (Clayton and Reidsville). Measurements taken were vigor ratings, stand counts, fresh and dry weights of roots and shoots, yield, and quality.

Results. The high rate of Scepter (0.57 kg/ha) and the no charcoal treatment was the most phytotoxic to tobacco. The high rate of charcoal (8.96 kg/ha) provided the most protection from Scepter. Vigor ratings were variable but the charcoal treatments were consistently better than the no charcoal treatments.

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Charcoal in the absence of any herbicide treatment again appeared to show a positive growth response early in the season.

N. Charcoal Water Rate Evaluation in Tobacco. This was initiated to determine if the rate of water could affect the amount of protection. This test had 3 rates of water (468, 2574, and 3978 liters/ha) with 1 rate of charcoal (8.96 kg/ha). This also involved Scepter but only 1 rate (0.57 kg ai/ha) was used. This was also a split-plot arrangement and was conducted at 2 locations (Clayton and Rocky Mount). The treatments were arranged such that charcoal and no charcoal transplant water treatments were side by side. Measurements taken were vigor ratings, stand counts, fresh and dry weights of roots and shoots, yield, and quality.

Results. The high rate of water did provide more protection from phytotoxic effects from Scepter than did the 2 lower rates. Charcoal transplant water treatments again appeared to provide a positive growth response to no charcoal in the absence of any herbicide early in the season. This difference disappeared about 4-5 weeks after transplanting.

O. Herbicide Screening for Possible Protection With Charcoal in Tobacco. Herbicides are listed in Table 24. This test was initiated to determine which herbicides charcoal applied in transplant water treatments may provide protection from phytotoxicity. This involved seven herbicides applied PPI at two locations (Rocky Mount and Reidsville). They were atrazine (AAtrex), chlorimuron (Classic), imazaquin (Scepter), pebulate (Tillam), pendimethalin (Prowl), dicamba (Banvel), and lactofen (Cobra). The treatments were arranged in a split-plot statistical arrangment such that each herbicide treatment had side by side comparisons of charcoal transplant water and regular transplant water treatments. Measurments taken included vigor ratings, stand counts, fresh and dry weights of roots and shoots, yield and quality. Vigor ratings were taken every two weeks until crop maturity.

Results. Yield data can be found in Table 24. Of the seven herbicides tested, charcoal transplant water treatments provided significant protection from Scepter, Classic, AAtrex, and to a lesser extent Dicamba. This protection was either noted in vigor ratings or yield at one or both locations. The level of protection was related, at least to some degree, to particular soil chemical and physical characteristics at a given site. Protection was most consistent with Scepter. It was also noted that Cobra, which is a new soybean herbicide that is very effective on many broadleaf weeds, did not injure tobacco in these trials. Further evaluation of this herbicide may make it a candidate for pursuit of a label for tobacco. Another observation in these trials was that the charcoal transplant water treatments appeared to provide a positive growth response in the absence of any herbicide treatment. It is not presently known why this response occurred.

II. Gradua

III. Postdc

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V. Manusc

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VII. Acknow

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II. Graduate Students:

Thomas Wiepke, "No-till Tobacco: Effect of Mulch on Herbicide Retention and Evaluation of Cover Crops."

III. Postdoctoral Fellows:

IV. Publications:

Walls, F. R., A. D. Worsham, W. K. Collins, F. T. Corbin and J. R. Bradley. 1987. Evaluation of imazaquin for weed control in flue-cured tobacco. Weed Sci. 36:824-829.

Worsham, A. D. and R. L. Davis. 1987. Weed Management in Burley Tobacco. Pages 11-21, in 1987 Burley Tobacco Information. N.C. Agric. Ext. Serv. Bull. AG 376.

Sheets, T. J. and A. D. Worsham. 1987. Effects of soil applied picloram and dicamba on flue-cured tobacco. Proc. Sou. Weed Sci. Soc. 40:87.

Worsham, A. D. and R. L. Lemons. 1987. Use of activated charcoal to reduce injury from potential tobacco herbicides. Proc. Sou. Weed Sci. Soc. 40:82.

V. Manuscripts Accepted for Publication:

Walls, F. R., F. T. Corbin, W. K. Collins, A. D. Worsham, J. R. Bradley and E. M. Lignowski. Absorption, translocation and metabolism of imazaquin in flue-cured tobacco. Weed Sci.

VI. Manuscripts in Review:

Whatley, L. and A. D. Worsham. Ragweed interference in flue-cured tobacco. Weed Sci.

VII. Acknowledgement:

Appreciation is expressed to the North Carolina Tobacco Foundation, Inc. for support of the Graduate Assistantship for work in no-till tobacco and for supporting the work on injury protection with charcoal.

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Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

Table 1. Herbicides Used in 1987

Company	Common Name or Disignation	Trade Name or Other Designation	Formulation
American Cyanamid	Imazaquin	Scepter	1.5 S
American Cyanamid	Pendimethalin	Prowl	4 EC
American Cyanamid	Imazaquin/ Pendimethalin	Squadron	2.33 EC
Hoechst Roussel	Glufosinate	Ignite	1.67 EC
Chevron	Clothodim	Select	2 EC
Chevron	Surfactant	X77	NA
Ciba-Geigy	Atrazine	Attrex	4 L
Dupont	Cinmethylin	Cinch	7 EC
Dupont	Chlorimuron	Classic	.25 DF
Elanco	Isopropalin	Paarlan	6 EC
FMC	Clomazone	Command	4 E
Helena	Crop Oil Conc.	Agridex	NA
ICI	Napropamide	Devrinol	2E + 4F
ICI	Paraquat	Gramoxone	1.5 S
ICI	Pebulate	Tillam	6 E
Nor Am	Diphenamid	Enide	90 W
PPG	Lactofen	Cobra	2 E
Sandoz	Dicamba	Banvel	4 E

TABLE 2. WSS
and Other Ab

ABBREVIATION
AMBEL
AMARE
CHEAL
DIGSA
ELEIN
GASDI
MOLVE
PANDI
POROL

Other a
PBI
PPI
SUR
OT
POT
GK
TM
CHAR-TPW
CHAR-RD
CRINJ
*from Compo

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Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

TABLE 2. WSSA-Approved Computer Code Abbreviations for Weeds* and Other Abbreviations Used in Reporting 1987 Research.

Weeds Reported in 1987 Research

ABBREVIATION*	WEED SPECIES
AMBEL	COMMON RAGWEED
AMARE	REDROOT PIGWEED
CHEAL	COMMON LAMBSQUARTERS
DIGSA	LARGE CRABGRASS
ELEIN	GROOSEGRASS
GASDI	HAIRY GALINSOGA
MOLVE	CARPETWEED
PANDI	FALL PANICUM
POROL	COMMON PURSLANE

Other abbreviations used for Methods of Application

PBI	Prebed soil incorporated
PPI	Pretransplant soil incorporated
SUR	Surface applied before transplanting
OT	Over-top tobacco immediately after transplanting
POT	Postemergence over-top tobacco 2 to 3 weeks after transplanting
GK	Application of herbicide to kill cover crop about 2 weeks before transplanting
TM	A tankmix of two or more herbicides
CHAR-TPW	Charcoal added to the transplant water
CHAR-RD	When transplants are dipped in a charcoal slurry
CRINJ	Crop injury

*from Composite List of Weeds, Weed Science 32, Suppl. 2.

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Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

02-22-1988 SUMMARY

North Carolina State University

HERBICIDE EVALUATION IN FLUE-CURED TOBACCO

Conducted at KINSTON,N.C. by A.D.WORSHAM AND R.W.LEMONS

Project 87-91-K with cooperator LOWER COASTAL PLAIN TOBACCO RESEARCH STATION

All rates are specified as lb/A

TABLE 3.

TRT NO	TREATMENT NAME		AI FD	lb/gal	RATE	BROW STGE	A C	DIGSA 5/20/87	CHEAL 5/20/87	CRINJ 5/20/87	DIGSA 5/9/87	CHEAL 6/9/87	CRINJ 6/9/87	DIGSA 8/12/87	CHEAL 8/12/87	CRINJ 8/12/87
1	CINCH	E	7.00		0.75	OT		92.5	93.3	0.0	98.0	98.0	0.0	97.3	98.5	0.0
2	CINCH	E	7.00		1.00	OT		98.0	98.0	1.3	99.0	99.0	0.0	99.0	99.0	0.0
3	SCEPTER	E	1.50		0.06	OT		98.0	99.0	2.5	99.0	99.0	1.3	98.0	99.0	0.0
4	SCEPTER	E	1.50		.095	OT		98.0	98.8	20.0	99.0	99.0	11.3	99.0	99.0	0.0
5	SCEPTER	E	1.50		0.06	OTTM		98.0	99.0	7.5	98.8	99.0	5.0	99.0	99.0	0.0
5	COMMAND	E	4.00		0.75	OTTM										
6	SCEPTER	E	1.50		0.06	OTTM		99.0	99.0	7.5	99.0	99.0	3.8	99.0	99.0	0.0
6	COMMAND	E	4.00		0.50	OTTM										
7	COBRA	E	2.00		0.50	SUR		95.5	95.0	0.0	97.8	97.8	0.0	97.8	98.5	0.0
8	COBRA	E	2.00		1.00	SUR		98.0	98.0	8.8	99.0	99.0	7.5	99.0	99.0	0.0
9	COMMAND	E	4.00		0.75	OT		99.0	99.0	0.0	99.0	99.0	0.0	99.0	99.0	0.0
10	COMMAND	E	4.00		1.00	OT		91.0	96.8	0.0	95.5	98.5	0.0	99.0	99.0	0.0
11	ENIDE	W	90	4.00		OT		99.0	97.0	0.0	99.0	99.0	0.0	99.0	98.8	0.0
12	DEVRINOL	E	4.00		1.00	OT		94.5	95.8	0.0	95.8	97.8	0.0	98.0	98.8	0.0
13	CULT CK							0.0	0.0	0.0	50.0	57.5	0.0	55.0	60.0	0.0
Least Significant Diff. (.05)=								4.5	4.1	3.0	4.1	5.1	2.7	2.8	4.6	0
Standard Deviation =								3.094	2.8336	2.1119	2.8175	3.5609	1.8988	1.9202	3.1833	0
Coeff. of Variability =								3.47	3.15	57.80	2.98	3.73	85.66	2.02	3.33	0

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TABLE 4.

TRT NO	TREATMENT NAME	
1	CINCH	
2	CINCH	
3	SCEPTER	
4	SCEPTER	
5	SCEPTER	
5	COMMAND	
6	SCEPTER	
6	COMMAND	
7	COBRA	
8	COBRA	
9	COMMAND	
10	COMMAND	
11	ENIDE	
12	DEVRINOL	
13	CULT CK	

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Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

01-26-1988 SUMMARY

North Carolina State University

HERBICIDE EVALUATION IN FLUE-CURED TOBACCO

Conducted at KINSTON, N.C. by A.D.WORSHAM AND R.W.LEMONS

Project 87-91-K with cooperator LOWER COASTAL PLAIN TOBACCO RESEARCH STATION

TABLE 4. All rates are specified as lb/A

TRT NO	TREATMENT NAME	FD	AI #/gal	RATE	GROW STGE	A C	YIELD #/A	GRADE INDEX	% SUGAR	%TA (HY)
1	CINCH	E	7.00	0.75	OT		2481.3	57.3	17.3	3.52
2	CINCH	E	7.00	1.00	OT		2554.0	62.5	17.8	3.68
3	SCEPTER	E	1.50	0.06	OT		2539.5	66.3	17.0	3.47
4	SCEPTER	E	1.50	.095	OT		2457.5	60.3	17.0	3.57
5	SCEPTER	E	1.50	0.06	OTTM		2508.5	61.5	17.3	3.45
5	COMMAND	E	4.00	0.75	OTTM					
6	SCEPTER	E	1.50	0.06	OTTM		2431.8	63.5	16.5	3.47
6	COMMAND	E	4.00	0.50	OTTM					
7	COBRA	E	2.00	0.50	SUR		2404.5	68.3	17.0	3.53
8	COBRA	E	2.00	1.00	SUR		2613.0	63.0	17.5	3.40
9	COMMAND	E	4.00	0.75	OT		2452.8	59.3	16.5	3.55
10	COMMAND	E	4.00	1.00	OT		2557.0	60.5	17.3	3.45
11	ENIDE	W	90	4.00	OT		2419.0	62.0	17.3	3.45
12	DEVRINOL	E	4.00	1.00	OT		2597.0	58.3	16.3	3.45
13	CULT CK						2361.3	60.3	17.8	3.50
Least Significant Diff. (.05)=							268.7	8.7	1.8	0.21
Standard Deviation =							186.08	6.0189	1.2459	.14393
Coeff. of Variability =							7.47	9.74	7.29	4.11

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Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

02-22-1988 SUMMARY

North Carolina State University

HERBICIDE EVALUATION IN FLUE-CURED TOBACCO

Conducted at REIDSVILLE,N.C. by A.D.WORSHAM AND R.W.LEMONS
Project 87-92-RD with cooperator UPPER PIEDMONT RESEARCH STATION

TABLE 5. All rates are specified as lb/A

TRT NO	TREATMENT NAME	AI FO	lb/gal	RATE	GROW STGE	A C	CRINJ 6/4/87	DIGSA 6/12/87	AMARE 6/12/87	CRINJ 6/12/87	DIGSA 8/15/87	AMARE 8/15/87	CRINJ 8/15/87
1	CINCH	E	7.00	0.75	OT		1.7	97.7	99.0	8.3	85.0	86.7	0.0
2	CINCH	E	7.00	1.00	OT		1.7	99.0	99.0	1.7	91.7	89.3	1.7
3	SCEPTER	E	1.50	0.06	GT		5.0	99.0	99.0	16.7	88.3	93.3	18.3
4	SCEPTER	E	1.50	.095	OT		15.0	99.0	99.0	23.3	94.7	96.0	33.3
5	SCEPTER	E	1.50	0.06	OTTM		6.7	99.0	99.0	18.3	99.0	99.0	15.0
5	COMMAND	E	4.00	0.75	OTTM								
6	SCEPTER	E	1.50	0.06	OTTM		3.3	99.0	99.0	16.7	99.0	99.0	13.3
6	COMMAND	E	4.00	0.50	OTTM								
7	COBRA	E	2.00	0.50	SUR		5.0	97.7	97.7	11.7	88.3	93.3	0.0
8	COBRA	E	2.00	1.00	SUR		6.7	98.7	99.0	1.7	93.0	94.0	5.0
9	COMMAND	E	4.00	0.75	OT		1.7	99.0	96.0	5.0	96.0	81.7	0.0
10	COMMAND	E	4.00	1.00	OT		1.7	99.0	99.0	8.3	99.0	88.3	0.0
11	ENIDE	W	90	4.00	OT		1.7	99.0	99.0	13.3	86.7	81.7	0.0
12	DEVRINOL	E	4.00	1.00	OT		1.7	99.0	99.0	1.7	86.7	83.3	0.0
13	CULT CK						0.0	36.7	46.7	3.3	30.0	30.0	0.0
Least Significant Diff. (.05)=							3.9	14.9	7.3	9.4	6.7	8.2	6.6
Standard Deviation =							2.298	8.8383	4.3466	5.5901	3.9626	4.8419	3.9016
Coeff. of Variability =							57.57	9.41	4.59	55.80	4.53	5.64	58.53

20002695O7

Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

NORTH CAROLINA STATE UNIVERSITY

HERBICIDE EVALUATION IN FLUE-CURED TOBACCO

TABLE 6.

Conducted at REIDSVILLE, N.C. by A.D.WORSHAM AND R.W.LEMONS
Project 87-92-RD with cooperator UPPER PIEDMONT RESEARCH STATION

TRT. NUM.	PEST. NAME	FORM	RATE #ai/A	GROW. STAGE	YIELD LBS/A	GRADE INDEX	% SUGAR	%TA (HY)
01	CINCH	7.00E	0.75	OT	2084.0	50.0	11.3	3.60
02	CINCH	7.00E	1.00	OT	1765.0	45.0	11.7	3.50
03	SCEPTER	1.50E	0.06	OT	1659.0	43.0	10.7	3.60
04	SCEPTER	1.50E	.095	OT	1715.3	43.3	9.0	3.90
05	SCEPTER	1.50E	0.06	OTTM	1891.6	48.8	10.3	3.70
05	COMMAND	4.00E	0.75	OTTM				
06	SCEPTER	1.50E	0.06	OTTM	2035.7	46.0	11.3	3.57
06	COMMAND	4.00E	0.50	OTTM				
07	COBRA	2.00E	0.50	SUR	2128.3	42.0	11.7	3.33
08	COBRA	2.00E	1.00	SUR	2028.7	49.0	11.0	3.57
09	COMMAND	4.00E	0.75	OT	1735.0	45.7	9.7	3.83
10	COMMAND	4.00E	1.00	OT	1599.6	42.3	10.7	3.63
11	ENIDE	0.90W	4.00	OT	1680.3	41.7	11.3	3.50
12	DEVRINOL	4.00E	1.00	OT	2111.7	52.0	10.3	3.70
13	CULT CK				1963.0	47.7	11.3	3.57
LEAST SIGNIFICANT DIFF. (.05)=					413.9	10.68	2.795	.3765
STANDARD DEVIATION =					244.4	6.307	1.658	.2234
COEFF. OF VARIABILITY =					13.02	13.74	15.36	6.180

2000269508

Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

02-22-1988 SUMMARY

North Carolina State University

PRE-POSTEMERGENCE HERBICIDE EVALATION FOR GRASS CONTROL IN TOBACCO

Conducted at REIDSVILLE,N.C. by A.D.WORSHAM AND R.W.LEMONS
Project 87-96-RD with cooperator UPPER PIEDMONT RESEARCH STATION
All rates are specified as lb/A

TABLE 7.

TRT NO	TREATMENT NAME	FD	AI $/gal	RATE	GROW STGE	A C	DIGSA 6/9/87	DIGSA 7/16/87	CRINJ 6/9/87	CRINJ 7/15/87	YIELD $/A	GRADE INDEX	% SUGAR	%TA (HY)
1	SELECT	E	2.00	.125	OT		94.5	98.5	0.0	0.0	2362.5	60.3	14.3	3.18
2	SELECT	E	2.00	0.25	OT		99.0	99.5	0.0	0.0	2638.8	62.3	14.0	3.10
3	SELECT	E	2.00	.125	POT		0.0	97.5	0.0	0.0	2778.5	59.3	14.0	3.27
4	SELECT	E	2.00	0.25	POT		0.0	99.3	0.0	0.0	2533.0	62.3	12.5	3.38
5	CULT CK						0.0	58.8	0.0	0.0	2745.0	57.0	13.5	3.07
Least Significant Diff. (.05)=							2.4	4.2	0	0	485.5	8.8	1.8	0.19
Standard Deviation =							1.5492	2.7125	0	0	315.1	5.7285	1.1618	.12315
Coeff. of Variability =							4.00	2.99	0	0	12.07	9.52	8.51	3.85

08-27-1987 SUMMARY

NORTH CAROLINA STATE UNIVERSITY

EVALUATION OF DEVRINOL IMPREGNATED ON FERTILIZER IN BURLEY TOBACCO

TABLE 8.

Conducted at WAYNESVILLE,N.C. by A.D.WORSHAM AND R.W.LEMONS
Project 87-60-W with cooperator MOUNTAIN RESEARCH STATION

TRT. NUM.	PEST. NAME	FORM	RATE #ai/A	GROW. STAGE	DIGSA 6/24/87	GASBI 6/24/87	CHEAL 6/24/87	CRINJ 6/24/87	DIGSA 7/8/87	GASBI 7/8/87	CHEAL 7/8/87	CRINJ 7/8/87
01	DEVRINOL	4.00E	1.00	PPI	91.0	96.5	93.0	0.0	98.0	99.0	97.0	0.0
02	DEVRINOL	4.00E	2.00	PPI	95.3	98.0	97.3	0.0	99.0	99.0	98.0	0.0
03	DEVRINOL ON-FERT.	4.00E	1.00	PPI	95.5	98.3	98.3	1.3	95.8	99.0	92.3	0.0
04	DEVRINOL ON-FERT.	4.00E	2.00	PPI	90.8	93.8	93.8	5.0	99.0	99.0	98.0	0.0
05	CULT CK				17.5	37.5	40.0	1.3	61.3	80.0	55.0	0.0
LEAST SIGNIFICANT DIFF. (.05)=					19.79	19.22	20.92	3.516	7.070	4.872	6.355	0
STANDARD DEVIATION =					12.84	12.47	13.58	2.282	4.588	3.162	4.125	0
COEFF. OF VARIABILITY =					16.46	14.71	16.08	152.1	5.065	3.321	4.684	0

2000269509

Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

NORTH CAROLINA STATE UNIVERSITY

EVALUATION OF DEVRINOL IMPREGNATED ON FERTILIZER IN BURLEY TOBACCO

TABLE 9.

Conducted at LAUREL SPRINGS, N.C. by A.D.WORSHAM AND R.W.LEMONS
Project 87-61-LS with cooperator UPPER MOUNTAIN RESEARCH STATION

TRT. NUM.	PEST. NAME	FORM	RATE #ai/A	GROW. STAGE	AMARE 7/7/87	POROL 7/7/87	MOLVE 7/7/87	PANDI 7/7/87	CRINJ 7/7/87	POROL 7/23/87	CRINJ 7/23/87	YIELD #/A
01	DEVRINOL	4.00E	1.00	PPI	93.5	81.3	96.8	86.3	0.0	78.8	0.0	2364.0
02	DEVRINOL	4.00E	2.00	PPI	95.5	88.8	98.0	89.5	0.0	95.3	0.0	2628.0
03	DEVRINOL 03 ON-FERT.	4.00E	1.00	PPI	95.8	93.8	99.0	92.3	0.0	95.5	0.0	2626.0
04	DEVRINOL 04 ON-FERT.	4.00E	2.00	PPI	98.3	95.8	99.0	95.8	0.0	98.3	0.0	2940.0
05	CULT CK				37.5	7.5	0.0	0.0	0.0	30.0	0.0	2278.0
LEAST SIGNIFICANT DIFF. (.05)=					15.88	14.25	3.062	14.32	0	9.876	0	367.0
STANDARD DEVIATION =					10.30	9.250	1.987	9.296	0	6.410	0	238.2
COEFF. OF VARIABILITY =					12.25	12.60	2.530	12.77	0	8.053	0	9.279

Table 10. Burley Tobacco on Farm Herbicide Test. 1987

Treatments	Rate #ai./A	Method Appl.	GASCI (5 loc)	AVE. % CONTROL AMBEL (4 loc)	A.GRASS* (6 loc)	S.BROADL** (16 ratings)
Prowl	1.0	PPI	62	79	83	91
Devrinol4F	2.0	OT	92	90	97	94
Enide	4.0	OT	90	93	97	95
Devrinol50W	2.0	OT	91	89	97	94
Paarlan	1.5	PPI	61	77	81	87

* A.GRASS= Large crabgrass, Goosegrass
** Small Seeded Broadleafs= R.Pigweed, C.Lambsquarter, C.Purslane, Carpetweed

2000269510

Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

Table 11. SUMMARY

NORTH CAROLINA STATE UNIVERSITY
NO-TILL TOBACCO VARIETY EVALUATION
CONDUCTED AT CLAYTON, N.C. BY A.D.WORSHAM AND R.W.LEMONS

TRT. NUM.	VARIETY	YIELD #/A	GRADE INDEX	% SUGAR	%TA (HY)
01	K 326	2099	49.3	22.3	2.18
02	NF 28	2627	51.4	21.9	2.33
03	C 319	2084	51.3	22.0	2.19
04	NF 22	2059	51.3	21.6	2.46
05	G 70	2196	50.9	22.9	2.15
06	NC 82	2118	48.9	22.6	1.98
07	M 373	2062	50.4	21.8	2.25
	LSD..05	595	7.6	1.3	.31
	S D	416	5.3	.92	.22
	C V	19	10	4	10

2000269511

Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

NORTH CAROLINA STATE UNIVERSITY
RYE VARIETY INFLUENCE FOR FLUE-CURED NO-TILL TOBACCO
Table 12.
CONDUCTED AT CLAYTON, N.C. BY A.D.WORSHAM AND R.W.LEMONS
PROJECT 87-97-C WITH COOPERATOR CENTRAL CROPS RESEARCH STATION

TRT. NUM.	PEST. NAME	FORM FORM	RATE #ai/A	GROW. STAGE	YIELD #/A	GRADE INDEX	% SUGAR	%TA (HY)
01	ABRUZZI RYE				2528	54	22.5	2.05
01	GRAMOXONE	1.5L	0.56	GK				
01	ENIDE	90W	6.0	OT				
01	COMMAND	6.0E	.75	POT				
02	ABRUZZI RYE				2580	56	21.8	2.25
02	GRAMOXONE	1.5L	0.56	GK				
02	ENIDE	90W	6.0	OT				
02	SCEPTER	1.5E	.06	POT				
03	ABRUZZI RYE				2990	58	21.5	2.13
03	GRAMOXONE	1.5L	0.56	GK				
03	ENIDE	90W	6.0	OT				
03	COMMAND	6.0E	.75	POTTM				
03	SCEPTER	1.5E	.06	POTTM				
04	SS 2 RYE				2387	60	21.3	2.10
04	GRAMOXONE	1.5L	0.56	GK				
04	ENIDE	90W	6.0	OT				
04	COMMAND	6.0E	.75	POT				
05	SS 2 RYE				2477	61	21.0	2.18
05	GRAMOXONE	1.5L	0.56	GK				
05	ENIDE	90W	6.0	OT				
05	SCEPTER	1.5E	.06	POT				
06	SS 2 RYE				2430	56	21.8	2.15
06	GRAMOXONE	1.5L	0.56	GK				
06	ENIDE	90W	6.0	OT				
06	COMMAND	6.0E	.75	POTTM				
06	SCEPTER	1.5E	.06	POTTM				
			LSD.05		575	6.4	1.28	.35
			S D		382	4.2	.848	.23
			C.V.%		15	7	4	10

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Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

Table 13. No-tillage flue-cured tobacco yield, grade index and leaf chemistry as affected by cover crop at the Central Crops Research Station, Clayton, NC 1987 - Tobacco Variety K326

--- Cover Crop ---		---------- Tobacco[a] ----------			
Type	Fall Sowing Rate(kg/ha)	Yield (kg/ha)[b]	Grade Index	Leaf Chemistry %Sugar	%TA
Rye	250[c]	3194cd	53a	18.6a	1.8c
Crimson Clover	28	3639ab	49bc	15.8b	2.1ab
Hairy Vetch	34	3822a	46c	14.7b	2.3a
Rye+CC[d]	94[c]+ 17	3300bcd	52ab	18.7a	1.9c
Rye+HV[d]	94 + 17	3444bc	51ab	18.4a	1.95bc
Conventional (no cover crop, normal tillage)		3050d	53a	18.3a	1.9c

[a]Means within a column followed by the same letter(s) are not significantly different at the 5% level of probability according to the FLSD test.

[b]To convert kg/ha to lb/A, multiply by 0.892

[c]250 kg/ha=4.0 bushels/A, 94 kg/ha=1.5 bushels/A

[d]CC=Crimson Clover, HV=Hairy Vetch

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Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

Table 14. No-tillage flue-cured tobacco yield, grade index and leaf chemistry as affected by cover crop at the Upper Coastal Plain Research Station, Rocky Mt., NC 1987 - Tobacco Variety NC 27

--- Cover Crop --- Type	Tobacco[a] Yield[b] (kg/ha)	Grade Index	Leaf Chemistry %Sugar	%TA
Rye	2014b	41a	21.2a	1.5a
Crimson Clover	2325b	53a	19.8a	1.7a
Hairy Vetch	2369b	49a	18.3a	1.9a
Rye+CC[c]	2274b	47a	20.7a	1.6a
Rye+HV[c]	2280b	43a	20.8a	1.5a
Conventional (no cover crop, normal tillage)	3212a	50a	22.7a	1.6a

[a]Means within a column followed by the same letter(s) are not significantly different at the 5% level of probability according to the FLSD test.

[b]To convert kg/ha to lb/A, multiply by 0.892

[c]CC=Crimson Clover, HV=Hairy Vetch

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Source: https://www.industrydocuments.ucsf.edu/docs/ysvk0000

Table 15. No-tillage flue-cured tobacco yield, grade index and leaf chemistry as affected by cover crop and sidedress nitrogen application at the Central Crops Research Station, Clayton, NC 1987 - Tobacco Variety K326

Cover Crop Type	Sidedress N (kg/ha)	Tobacco[a] Yield[b] (kg/ha)	Grade Index	Leaf Chemistry %Sugar	%TA
Crimson Clover	0	3412	53	18.0	1.9
Crimson Clover	22	3640	49	15.7	2.1
Hairy Vetch	0	3663	48	15.6	2.2
Hairy Vetch	22	3823	46	14.7	2.2
Rye+CC[c]	0	2773	53	20.0	1.5
Rye+CC	22	3300	52	18.7	1.8
Rye+HV[c]	0	3107	52	18.9	1.7
Rye+HV	22	3445	51	18.4	1.9

[a] No significant differences at the 5% level, Yield C.V.=6.89 Grade C.V.=4.25, %Sugar C.V.=6.28, %TA C.V.=8.48

[b] To convert kg/ha to lb/A, multiply by 0.892

[c] CC=Crimson Clover, HV=Hairy Vetch

2000269515

Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

02-22-1988 SUMMARY

North Carolina State University

NO-TILL VS.CONVENTIONAL BURLEY TOBACCO

Conducted at LAUREL SPRINGS,N.C. by A.D.WORSHAM AND R.W. LEMONS
Project 87-69-LS with cooperator UPPER MOUNTAIN RESEARCH STATION
All rates are specified as lb/A

TABLE 16.

TRT NO	TREATMENT NAME	FD	AI %/gal	RATE	GROW STGE	A C	AMARE 7/7/87	POROL 7/7/87	WOLVE 7/7/87	PANDI 7/7/87	CRINJ 7/7/87	AMARE 7/23/87	POROL 7/23/87	CRINJ 7/23/87	Yield #/A
1	GRAMOXONE	L	1.50	0.56	GK		93.00	93.25	96.8	99.0	0.0	57.5	82.50	0.0	
1	ENIDE	W	90	6.00	OT										
2	GRAMOXONE	L	1.50	0.56	GK		98.00	99.00	99.0	99.0	0.0	93.5	92.00	0.0	
2	DEVRINOL	E	4.00	2.00	OT										
3	GRAMOXONE	L	1.50	0.56	GK		99.00	99.00	99.0	99.0	0.0	98.0	94.00	0.0	
3	SCEPTER	E	1.50	.095	OT										
4	GRAMOXONE	L	1.50	0.56	GK		92.88	97.88	99.0	99.0	0.0	83.5	90.38	0.0	
4	COMMAND	E	4.00	1.00	OT										
5	GRAMOXONE	L	1.50	0.56	GK		99.00	99.00	99.0	99.0	0.0	85.8	90.75	0.0	
5	SCEPTER	E	1.50	.060	OTTM										
5	COMMAND	E	4.00	0.75	OTTM										
6	GRAMOXONE	L	1.50	0.56	GK		98.03	98.35	98.1	100.5	-0.4	41.4	76.81	0.0	
7	ENIDE	W	90	6.00	OT		91.00	85.00	97.0	67.0	1.3	97.0	82.25	0.0	3092
8	DEVRINOL	E	4.00	2.00	OT		78.50	84.75	92.0	53.8	2.5	98.0	92.25	0.0	2960
9	SCEPTER	E	1.50	.095	OT		91.25	90.00	97.0	53.8	0.0	96.0	83.75	0.0	3048
10	COMMAND	E	4.00	1.00	OT		91.00	99.00	94.5	99.0	5.0	99.0	99.00	0.0	3062
11	SCEPTER	E	1.50	.060	OTTM		93.75	99.00	98.0	99.0	2.5	99.0	99.00	0.0	3016
11	COMMAND	E	4.00	0.75	OTTM										
12	CULT CK						0.00	20.00	12.5	20.0	1.3	87.3	79.75	0.0	2636
Least Significant Diff. (.05)=							11.72	12.35	11.2	32.1	3.3	15.7	19.58	0	NS
Standard Deviation =							8.1189	8.5553	7.7542	22.22	2.2569	10.871	13.561	0	
Coeff. of Variability =							9.50	9.65	8.60	26.99	223.44	12.59	15.32	0	8

2000269516

Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

NORTH CAROLINA STATE UNIVERSITY
RYE VARIETY INFLUENCE(SHORT VS TALL) FOR BURLEY NO-TILL TOBACCO

TABLE. 17

Conducted at Waynesville,N,C. by A.D.WORSHAM and R.W.LEMONS
Project 87-68-W with cooperator MOUNTAIN RESEARCH STATION

	% CHEAL CONTROL 7-8-87			% ELEIN CONTROL 7-8-87		
TRT.a	SS 2	ABRUZZI	CONV.	SS 2	ABRUZZI	CONV.
PQ.+ENIDE	97a	99a	76b	99a	97ab	94ab
PQ.+DEV.	99a	99a	75b	97ab	99a	93ab
PQ.+SCEP.	99a	99a	99a	91abc	95ab	74cd
PQ.+COMM.	99a	99a	89a	97ab	99a	98ab
PQ.+SCEP.+ COMM.	99a	99a	99a	96ab	99a	98ab
PQ.CHECK	97a	95a	0c	60d	80c	10e

	% DIGSA CONTROL 7-8-87			% AMARE CONTROL 7-8-87		
TRT.	SS 2	ABRUZZI	CONV.	SS 2	ABRUZZI	CONV.
PQ.+ENIDE	97a	96a	93ab	99a	99a	83bc
PQ.+DEV.	98a	98a	90ab	99ab	99a	77cb
PQ.+SCEP.	86abc	92ab	72c	99a	99a	99a
PQ.+COMM.	95a	99a	97a	99a	99a	99a
PQ.+SCEP.+ COMM.	95a	98a	96a	99a	99a	99a
PQ.CHECK	49d	76bc	10e	97a	95ab	0d

*PQ.+ENIDE = GRAMOXONE .56 #ai./A GK + ENIDE 6.0 #ai./A OT
PQ.+DEV. = GRAMOXONE .56 #ai./A GK + DEVRINOL 1.0 #ai./a OT
PQ.+SCEP.= GRAMOXONE .56 #ai./A GK + SCEPTER .095 #ai./A OT
PQ.+COMM.= GRAMOXONE .56 #ai./A GK + COMMAND 1.0 #ai./A OT
PQ.+SCEP.+ COMM.= GRAMOXONE .56 #ai./A GK + SCEPTER .06 #ai./A + COMMAND .75 #ai./A OTTM
PQ. CHECK = GRAMOXONE .56 #ai./A GK

2000269517

Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

NORTH CAROLINA STATE UNIVERSITY
RYE VARIETY INFLUENCE(SHORT VS TALL) FOR BURLEY NO-TILL TOBACCO

TABLE 18.

Conducted at Waynesville,N,C. by A.D.WORSHAM and R.W.LEMONS
Project 87-68-W with cooperator MOUNTAIN RESEARCH STATION

	% CHEAL CONTROL 8-20-87		
TRT.	SS 2	ABRUZZI	CONV.
PQ.+ENIDE	98a	96a	61b
PQ.+DEV.	93a	95a	87a
PQ.+SCEP.	97a	99a	98a
PQ.+COMM.	99a	99a	97a
PQ.+SCEP.+ COMM.	99a	99a	98a
PQ.CHECK	13c	53b	5c

	% CRINJ 7-8-87			
TRT.	SS 2	ABRUZZI	CONV.	MEANS
PQ.+ENIDE	0	0	4	1c
PQ.+DEV.	0	1	4	2c
PQ.+SCEP.	23	38	20	27a
PQ.+COMM.	0	4	4	3c
PQ.+SCEP.+ COMM.	11	13	14	13b
PQ.CHECK	0	5	0	2c
MEANS	6b	10a	8ab	

*PQ.+ENIDE = GRAMOXONE .56 #ai./A GK + ENIDE 6.0 #ai./A OT
PQ.+DEV. = GRAMOXONE .56 #ai./A GK + DEVRINOL 1.0 #ai./a OT
PQ.+SCEP.= GRAMOXONE .56 #ai./A GK + SCEPTER .095 #ai./A OT
PQ.+COMM.= GRAMOXONE .56 #ai./A GK + COMMAND 1.0 #ai./A OT
PQ.+SCEP.+ COMM.= GRAMOXONE .56 #ai./A GK + SCEPTER .06 #ai./A + COMMAND .75 #ai./A OTTM
PQ. CHECK = GRAMOXONE .56 #ai./A GK

2000269518

Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

NORTH CAROLINA STATE UNIVERSITY
RYE VARIETY INFLUENCE(SHORT VS TALL) FOR BURLEY NO-TILL TOBACCO

TABLE 19.

Conducted at Waynesville,N,C. by A.D.WORSHAM and R.W.LEMONS
Project 87-68-W with cooperator MOUNTAIN RESEARCH STATION

TRT.	YIELD LBS/A SS 2	ABRUZZI	CONV.	MEANS
PQ.+ENIDE	3008	2903	2618	2843a
PQ.+DEV.	2923	3023	2830	2925a
PQ.+SCEP.	2271	2263	2469	2334b
PQ.+COMM.	2987	2984	2965	2979a
PQ.+SCEP.+ COMM.	2787	2964	3022	2924a
PQ.CHECK	2180	2559	2528	2422b
MEANS	2693a	2783a	2739a	

*PQ.+ENIDE = GRAMOXONE .56 #ai./A GK + ENIDE 6.0 #ai./A OT
PQ.+DEV. = GRAMOXONE .56 #ai./A GK + DEVRINOL 1.0 #ai./a OT
PQ.+SCEP.= GRAMOXONE .56 #ai./A GK + SCEPTER .095 #ai./A OT
PQ.+COMM.= GRAMOXONE .56 #ai./A GK + COMMAND 1.0 #ai./A OT
PQ.+SCEP.+ COMM.= GRAMOXONE .56 #ai./A GK + SCEPTER .06 #ai./A + COMMAND .75 #ai./A OTTM
PQ. CHECK = GRAMOXONE .56 #ai./A GK

1987 ON-FARM EVALUATION OF NO-TILL BURLEY TOBACCO
A.D.WORSHAM,R.L.DAVIS AND R.W.LEMONS

TABLE 20.

LOCATION	TRT. NO.	METHOD	YIELD #/A	$/A	$/CWT
Mitchell Co.	1	Conventional	1213	1800	148.39
	2	No-Till	2318	3607	155.61
Buncombe Co.	1	Conventional	2100	3250	154.76
	2	No-Till	2150	3370	156.74

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TABLE 21.

TRT NO	TREATMENT NAME		AI FD	#/gal	RATE	GROW STGE
1	SCEPTER	E	1.50		.250	OT
1	CHAR-TPM					
2	SCEPTER	E	1.50		.500	OT
2	CHAR-TPM					
3	SCEPTER	E	1.50		.250	OT
3	CHAR-RD					
4	SCEPTER	E	1.50		.500	OT
4	CHAR-RD					
5	SCEPTER	E	1.50		.250	OT
5	NO CHAR					
6	SCEPTER	E	1.50		.500	OT
6	NO CHAR					
7	CULT CK					
7	NO CHAR					
8	CULT CK					
8	CHAR-TPM					
9	CULT CK					
9	CHAR-RD					

Least Significant Diff. (.05)=
Standard Deviation =
Coeff. of Variability =

2000269519

Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

01-27-1988 SUMMARY

North Carolina State University

CHARCOAL AS A PROTECTANT FROM HERBICIDE INJURY IN TOBACCO

Conducted at KINSTON,N.C. by A.D.WORSHAM AND R.W.LEMONS

Project 87-69-K with cooperator LOWER COASTAL PLAIN TOBAC

TABLE 21. All rates are specified as lb/A

TRT NO	TREATMENT NAME		AI FD	# /gal	RATE	GROW STGE	A C	CRINJ 5/20/87	CRINJ 6/1/87	CRINJ 6/25/87	YIELD #/A	GRADE INDEX	% SUGAR	NTA (HYI
1	SCEPTER	E	1.50		.250	OT		13.8	7.5	3.8	2458.3	56.8	16.3	3.85
1	CHAR-TPW													
2	SCEPTER	E	1.50		.500	OT		35.0	25.0	17.5	2297.5	50.5	16.5	3.88
2	CHAR-TPW													
3	SCEPTER	E	1.50		.250	OT		21.3	18.8	17.5	2244.5	54.3	16.0	3.80
3	CHAR-RD													
4	SCEPTER	E	1.50		.500	OT		42.5	40.0	45.0	2144.0	61.3	14.8	3.93
4	CHAR-RD													
5	SCEPTER	E	1.50		.250	OT		22.5	15.0	12.5	2269.5	52.8	16.0	3.68
5	NO CHAR													
6	SCEPTER	E	1.50		.500	OT		42.5	22.5	20.0	2260.8	51.0	16.8	3.80
6	NO CHAR													
7	CULT CK							0.0	0.0	0.0	2508.5	53.5	16.8	3.63
7	NO CHAR													
8	CULT CK							0.0	0.0	0.0	2491.3	60.8	16.5	3.70
8	CHAR-TPW													
9	CULT CK							0.0	0.0	0.0	2428.8	61.0	16.0	3.80
9	CHAR-RD													
Least Significant Diff. (.05)=								8.1	9.4	7.2	146.4	8.6	2.2	0.20
Standard Deviation =								5.3642	6.4549	4.9183	100.33	5.8858	1.5184	.13827
Coeff. of Variability =								28.21	45.12	38.08	4.28	10.56	9.39	3.65

2000269520

Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

02-22-1988 SUMMARY

North Carolina State University

CHARCOAL AS A PROTECTANT FROM HERBICIDE INJURY IN TOBACCO

Conducted at REIDSVILLE,N.C. by A.D.WORSHAM AND R.W.LEMONS
Project 87-70-RD with cooperator UPPER PIEDMONT RESEARCH S
All rates are specified as lb/A

TABLE 22.

TRT NO	TREATMENT NAME	FD	AI #/gal	RATE	GROW STGE	A C	CRINJ 6/4/87	CRINJ 6/12/87	CRINJ 7/16/87	YIELD #/5PLN
1	SCEPTER	E	1.50	.250	OT		10.0	37.5	43.8	9.3
1	CHAR-TPW									
2	SCEPTER	E	1.50	.500	OT		10.0	35.0	48.8	7.3
2	CHAR-TPW									
3	SCEPTER	E	1.50	.250	OT		50.0	67.5	68.8	6.5
3	CHAR-RD									
4	SCEPTER	E	1.50	.500	OT		55.0	73.8	81.3	3.3
4	CHAR-RD									
5	SCEPTER	E	1.50	.250	OT		16.3	58.8	62.5	7.5
5	NO CHAR									
6	SCEPTER	E	1.50	.500	OT		26.3	71.3	81.3	3.5
6	NO CHAR									
7	CULT CK						3.8	22.5	13.8	9.5
7	NO CHAR									
8	CULT CK						2.5	8.8	5.0	9.8
8	CHAR-TPW									
9	CULT CK						18.8	16.3	23.8	9.0
9	CHAR-RD									
Least Significant Diff. (.05)=							17.8	19.6	21.5	3.3
Standard Deviation						=	12.214	13.445	14.741	2.2771
Coeff. of Variability						=	57.11	30.93	30.94	31.29

2000269521

Source: https://www.industrydocuments.ucsf.edu/docs/ysvk0000

01-26-1988 SUMMARY

North Carolina State University

INCORPORATED HERBICIDE EVALUATION WITH CHARCOAL AS A PROTECTANT IN TOBACCO
Conducted at REIDSVILLE,N.C. by A.D.WORSHAM AND R.W.LEMONS
Project 87-93-RD with cooperator UPPER PIEDMONT RESEARCH STATION
All rates are specified as lb/A

TABLE 23.

TRT NO	TREATMENT NAME	FD	AI #/gal	RATE	GROW STGE	A C	CRINJ 6/4/87	CRINJ 6/12/87	CRINJ 7/16/87	YIELD #/5PLN
1	SQUADRON	E	2.30	.862	PBI		38.8	81.3	72.5	7.5
2	SCEPTER	E	1.50	.125	PBI		30.0	81.3	80.0	4.8
3	PROWL	E	6.00	0.75	PBI		6.3	17.5	11.3	12.0
4	SQUADRON	E	2.30	.862	PBI		20.0	45.0	45.0	10.0
4	CHAR-TPW									
5	SCEPTER	E	1.50	.125	PBI		12.5	68.8	63.8	6.5
5	CHAR-TPW									
6	PROWL	E	6.00	0.75	PBI		0.0	7.5	8.8	13.5
6	CHAR-TPW									
7	CULT CK						6.3	8.8	7.5	15.0
8	CULT CK						2.5	3.8	6.3	11.5
8	CHAR-TPW									
Least Significant Diff. (.05)=							22.1	20.4	15.9	3.6
Standard Deviation =							15.035	13.84	10.842	2.4485
Coeff. of Variability =							103.47	35.29	29.40	24.26

TABLE 24. Yield of Flue-Cured Tobacco With 7 Herbicides With and Without Charcoal Transplant Water Treatments. F. H. Yelverton, A. D. Worsham, and R. W. Lemons

Treatment	Yield (lbs./A)			
	Rocky Mount		Reidsville	
	char.	no char.	char.	no char.
Scepter	1647	988	1377	796
Cobra	2682	2822	2025	2161
Classic	2058	2034	1672	1052
Prowl	2635	2496	2193	2268
Tillam	2458	2540	2242	2245
Dicamba	178	156	940	872
Atrazine	367	421	870	392
Check	2535	2576	1858	2139

2000269522

Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

Title: NC 03905 Limited Growth of Metabolic Sinks to Enhance Quality of Flue-cured Tobacco.

Project Leader: H. Seltmann (USDA, ARS)

I. Summary of Research:

A. Regional Tobacco Growth Regulator Committee Tests.

1. Preliminary Sucker Control Test.

The study emphasized an experimental, SDS-36991 (SDS) from Fermenta Plant Protection Company (formerly Diamond Shamrock). In the interpretation of the data one had to take into consideration the fact that a late afternoon shower occurred after the second applications at the Oxford (NO) location and after the third applications at the Kinston (NK) location. No reapplications of chemicals were made so that effectiveness in sucker control under such conditions could be observed (Table 1).

SDS in sequential applications with Prime+ at 45 mg/plant (#4; #5) was not as effective as fatty alcohols (FA) followed by the MH check (#3). However, when SDS and Prime+ were in a tankmix effectiveness was greater, even with reduced rates of Prime+ (compare #8 and #9 with #4 and #5). The effect of the shower on the second applications at NO was obvious in treatments #6 and #7 where MH was involved. From the comparison of #6 and #7 it would appear that FA at 4% was more effective then SDS at 75 mg/plant.

2. Advances Sucker Control Test.

The advanced test, according to protocol, had treatments that passed the preliminary test in 1986. SDS-36991 (SDS) was the experimental under study. The unexpected late afternoon showers that affected the preliminary test had to be taken into consideration in the interpretation of the results in the advanced test (Table 2).

As in the preliminary test, SDS as a tankmix with Prime+ at reduced rates was effective (#8 and #9). The late afternoon shower at NO after the second applications reduced effectiveness, especially when MH was in the tankmix (#5, #6, and #7).

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Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

It would appear from these results that the experimental SDS and Prime+ at a reduced rate when applied as a tankmix will be an effective sucker controlling combination.

Treatments selected for chemical and physical properties determinations did not show any major changes in the cured leaf from the checks (Table 3), but there were some unusual differences between the checks and some of the experimental treatments. For example, the highest value for total alkaloids was with SDS/SDS/MH (#4) when MH is usually associated with lowered values of total alkaloids; the highest as well as the lowest values for reducing sugars were from treatments that all included MH (#3, #4, #5, and #7), which is usually associated with increased values of reducing sugars; the lowest and highest values for total ash included MH in the treatment (#3 and #4), yet MH is usually associated with lowered values of total ash; some of the higher values for filling values included MH (#3, #4, and #5), which is usually associated with lowered values for filling value; the two highest values for equilibrium moisture (#4 and #8) have the highest degrees of sucker control, yet have the lowest value for reducing sugars. Tobaccos high in reducing sugars are usually high in equilibrium moisture values. High temperatures, wash-offs of some applications, and an extended harvesting season are offered as reasons for the varying responses from treatments.

B. Carry-over Effect to Cover Crop of Flumetralin.

Earlier studies with a dinitroaniline (DNA) type sucker controlling agent showed an effect on the succeeding wheat cover crop. The effect was attributed to the addition of a DNA to another DNA already present in the soil as a herbicide to control weeds in the tobacco crop. The present study utilized MH and flumetralin, a DNA type compound, for sucker control and the herbicides Paarlan, Devrinol, Prowl, Enide, and Tillam that are labelled for tobacco. Of these, Paarlan and Prowl are of the DNA type. The herbicides were applied according to label on plots that were four tobacco plot-rows in width. Sucker control with MH and flumetralin was also according to label. After the tobacco stalks were cut, the land was disked and sown in wheat. The wheat was sampled when it was 7-15 cm in height by counting and weighing the plants in a square, 30 cm on a side, positioned randomly five times through the middle of hte herbicide plots.

2000269524

Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

Results showed that the use of flumetralin as a sucker controlling agent reduced the growth of wheat (Table 4). The greatest effect on number of plants present occurred when flumetralin was used on tobacco plants where weeds had been controlled with Paarlan and Prowl, the DNA type herbicides. The results also indicated that some of the herbicides in the absence of flumetralin affected the growth of the wheat either in number (germination) and/or weight (growth) of the individual plants.

Enide is the least offensive (carryover) herbicide in the absence of flumetralin. Flumetralin in the absence of the herbicides has an effect and its effect appeared to be aggrevated to some extent by the presence of each of the herbicides.

C. The Effects of Dicamba on Flue-cured Tobacco.

The illegal use of dicamba as a yellowing agent in the culture of flue-cured tobacco received considerable publicity during the beginning of 1987. Consequently, studies were planned to obtain additional information from applications of dicamba on the growth, quality, chemical characteristics, etc. of flue-cured tobacco and to demonstrate to interested parties (NCDA inspectors, extension personnel, tobacco company representatives, etc.) the field appearance of treated plants

Plants that had been topped and had suckers controlled were treated with 15, 30, or 60 mg/plant (0.2, 0.4, or 0.8 lb/acre, respectively) of dicamba about one week after the removal of the second priming. When all the leaves yellowed (5-7 days) all were harvested on the same day. The leaves were divided into two or three stalk positions depending upon how many leaves were in the field. Untreated checks were primed as the leaves yellowed normally. After harvest was completed the plant stalks were allowed to remain in the field so that the effect of treatment could be observed.

Eighteen hours after application epinasty of the upper leaves was obvious from all treatments of dicamba. Yellowing of leaves occurred more rapidly with the larger amounts applied. In some instances leaf removal was aggrevated by the fact that the leaves did not snap cleanly off the stalk. Instead a piece of stem tissue of varying lengths directly below the attachment of the petiole to the stem came off with

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Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

the leaf. The piece of stem tissue was still present after curing and could be indicative of the use of dicamba.

One to two weeks after harvest of the leaves from the dicamba treated plants, the stalks showed signs of tissue deterioration. The stalks blackened and the extensions of the petiolar wings clasping the stems were yellow. On not treated stalks as well as the extensions of the petiolar wings remained green long after harvest was completed.

Growth that occurred after application of dicamba was typical of the effect dicamba has on broad-leaved plants. Growth of auxillary buds that were not totally controlled was distorted. The upper few centimeters of the stalks on some smaller plants that probably were replants and still had the potential of some stalk elongation were crooked.

Yield of the tobacco that received the applications of dicamba was reduced with increased amounts when compared to the check (Table 5). Dollars per hundred weight were less for the treated with the greater amount applied giving a higher value. This was attributed to the fact that all treatments which had slightly different amounts of yellowing due to the amount of dicamba applied were harvested on the same day. All treatments were cured in the same barn and the differences in yellowing were not considered during the cure. If one had used just one rate of dicamba, one would have cured for the maximum bright color.

Chemical and physical properties analyses of the cured leaf showed that total alkaloids were reduced with dicamba treatment (Table 6). This can be attributed to the fact that treated leaves did not remain on the plant as long to accumulate the alkaloids as did the check.

The same may be said about total ash. Since dicamba readily translocates throughout plants and accumulates in tissues having rates of metabolism some of the effect may have been directly on root tips and root hair zone, the origin of alkaloid synthesis and ion absorption, respectively. Reducing sugars increased from dicamba treatment. This can be attributed to the changed physiology that breaks down stored starch more readily.

2000269526

Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

D. Combinations of Prime+ and SDS-36991.

Earlier greenhouse studies have shown that Prime+ and SDS-36991 (SDS) were compatible as a tankmix for sucker control. Of greatest interest was the small amount per plant that was effective. At present the labelled amount for Prime is 1.2 lb/acre in 50 gallons of spray solution and the experimental SDS is effective at 1.0 lb/acre in 50 gallons of spray solution. These materials have been studied as a tankmix at reduced amounts by the Regional Tobacco Growth Regulator Committee (See I., 1. of this report), but not at the low rates reported here. Prime at 0, 5.2, 10.7, and 15.7 mg/plant and SDS at 0, 3.5, 7.0, 10.5, and 18.5 mg/plant were applied once with 20 ml/plant downstalk with a Hydragun, singly or in all possible combinations as tankmixes to plants topped in full flower. All elongated suckers because of the flowering stage of the plants were removed prior to the applications. Topped and not suckered check produced 900-1000 gm of suckers per plant. Sucker control was determined on each of nine plants per treatment at two locations in the field. Results are given in Table 7.

Sucker control by any means that resulted to 95% would be considered very acceptable. Prime+ singly at 15.7 mg/plant resulted in 95% control. Prime+ at 5.2 mg with SDS at 18.5 mg/ plant as a tankmix resulted in 94% control. Furthermore, the tankmix showed synergism according to Colby (1967). If adaptable, chemical residues and costs to the grower for sucker control will be greatly reduced.

IV. Publications:

Seltmann, H., and T. J. Sheets. Sucker control and maleic hydrazide residues after simulated rain and MH reapplication. Tob. Sci. 31:82-87. 1987.

Seltmann, H. Topping and sucker control. Burley Tobacco Information - 1987. NC Agricultural Extension Service, NCSU, Raleigh, NC pp. 25-28. 1987.

X. Acknowledgements:

Many thanks to Joseph A. Priest for excellent technical assistance.

Table 1. 1987 Preliminary Regional Sucker Control Test: Flue-cured.

2000269527

Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

Table 1. 1987 Preliminary Regional Sucker Control Test: Flue-cured.

Treatment	Percent Control NK*	Percent Control NO	Percent Control Mean	Yield (lb/a)	Price index ($/cwt)	Acre index ($/a)	Qlty.** index	Degree of injury	Total alkaloids (%)	Reducg. sugars (%)
1. TNS	0	0	0	1871	160	2975	63	-	3.23	14.1
2. HS	36	44	40	2154	160	3440	56	-	3.46	14.7
3. FA/FA/MH 4%/4%/170 mg	88	100	94	2644	161	4240	57	0	3.53	15.6
4. SDS/SDS/Prime+ 75 mg/75 mg/45 mg	28	66	47	2399	159	3801	56	0	3.63	14.7
5. SDS/SDS/Prime+ 114 mg/114 mg/45 mg	48	84	66	2409	158	3788	57	0	3.63	15.4
6. FA/(FA + MH) 4%/(4% + 170 mg)	98	47	73	2421	160	3853	57	0	3.45	15.1
7. SDS/(SDS + MH) 75 mg/(75 mg + 170 mg)	93	22	58	2281	163	3699	60	0	3.58	14.3
8. SDS/(SDS + Prime+) 75 mg/(75 mg + 23 mg)	94	72	83	2411	161	3864	55	0	3.58	15.2
9. SDS/(SDS + Prime+) 75 mg/(75 mg + 45 mg)	99	78	89	2680	159	4259	54	0	3.46	17.1

*NK = Kinston; NO = Oxford
**Quality index (Wernsman-Price) is a 1-99 rating based on government grade. High ratings are best.

2000269528

Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

Table 2. 1987 Advanced Regional Sucker Control Test: Flue-Cured.

Treatment	Percent Control			Yield (lb/a)	Price index ($/cwt)	Acre index ($/a)	Quality** index	Degree of injury
	NK*	NO	Mean					
1. TNS	0	0	0	1872	154	2287	61	-
2. HS	44	30	37	2481	160	3965	61	-
3. FA/FA/MH 4%/4%/170 mg	35	99	67	2750	158	4320	55	0
4. SDS/SDS/MH 114 mg/114 mg/170 mg	89	98	94	2811	158	4424	56	0
5. FA/(FA + MH) 4%(4% + 170 mg)	91	37	64	2630	160	4185	59	0
6. SDS/(SDS + MH) 114 mg/(114 mg + 170 mg)	93	17	55	2697	160	4322	57	0
7. SDS/(SDS + MH) 151 mg/(151 mg + 170 mg)	96	37	67	2655	162	4292	60	0
8. SDS/(SDS + Prime+) 114 mg/(114 mg + 45 mg)	100	86	93	2946	156	4569	50	0
9. SDS/(SDS + Prime+) 114 mg/(114 mg + 23 mg)	96	85	91	2801	157	4371	53	0

*NK = Kinston; NO = Oxford
**Quality index (Wernsman-Price) is a 1-99 rating based on governmnet grade. High ratings are best.

2000269529

Table 3. 1987 Advanced Prod...

Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

*NK = Kinston; NO = Oxford
**Quality index (Wernsman-Price) is a 1-99 rating based on governmnet grade. High ratings are ...

Table 3. 1987 Advanced Regional Sucker Control Test: Flue-cured

	Treatment	Moisture (%)	Total alkaloids (%)	Reducg. sugars (%)	TVB-nicotine (%)	Total ash (%)	Filling value (ml/100gm)	Eqlibrm. moisture (%)	Sucker Control (%)
1.	HS	3.2	3.66	18.0	.150	10.02	363	12.44	37
2.	FA/FA/MH 4%/4%/170 mg	2.9	3.62	19.3	.141	9.46	376	12.89	67
3.	SDS/SDS/MH 114 mg/114 mg/170 mg	3.1	3.89	15.6	.170	10.99	384	12.91	94
4.	FA/(FA + MH) 4%94% + 170 mg)	3.0	3.73	16.9	.164	10.32	383	12.60	64
5.	SDS/(SDS + MH) 151 mg/(151 mg + 170 mg)	2.9	3.63	18.5	.147	10.09	365	12.86	67
6.	SDS/(SDS + Prime+) 114 mg/(114 mg + 45 mg)	2.8	3.58	17.7	.152	10.56	350	13.07	93

2000269530

Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

Table 4. Effect on a wheat cover crop following tobacco from the use of MH or flumetralin for sucker control in the absence or presence of different herbicides.

Herbicide	Growth Reg.	No.	Wheat* wt. (gm)	Wt./Plant (gm)
---	MH	61.2	72.0	1.18
Paarlan	MH	55.5	49.5	0.89
Devrinol	MH	65.2	54.8	0.84
Prowl	MH	65.2	69.3	1.06
Enide	MH	66.5	76.0	1.14
Tillam	MH	64.5	53.3	0.83
---	Flumetralin	57.5	46.8	0.81
Paarlan	Flumetralin	46.8	38.8	0.83
Devrinol	Flumetralin	56.5	44.0	0.78
Prowl	Flumetralin	47.7	41.2	0.86
Enide	Flumetralin	55.0	44.8	0.82
Tillam	Flumetralin	55.2	48.5	0.88

*Mean of 3 reps; 5 subsamples per rep; Whiteville, 1986 and 1987.

Table 5. Effect of Dicamba on Agronomic Characteristics.*

	Yield	$/cwt	$/A	Quality Index
Check	2078	159	3353	52
15 mg	1973	146	2812	31
30 mg	1792	153	2698	36
60 mg	1569	157	2441	37

*Means from Kinston, Clayton, and Oxford

2000269531

Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

Table 6. Effect of Dicamba on Chemical and Physical Properties.*

	Total alkaloids (%)	Reducing sugars (%)	Total Ash (%)
Check	2.79	22.2	9.20
15 mg	2.47	24.6	8.00
30 mg	2.67	24.4	7.99
60 mg	2.49	24.5	7.79

*Means from Kinston, Clayton, and Oxford.

Table 7. Percent Control of Sucker Growth on Field-Grown Flue-cured McNair 373 Plants.

Prime+ mg/plant	SDS-36991 (mg/plant)				
	0	3.5	7.0	10.5	18.5
0	0	20	49	40	50
5.2	43	79*	77*	85*	94*
10.5	74	83*	93*	90*	96*
15.7	95	93	95	96	98

*Treatment demonstrated syngerism according to Colby (1967).

2000269532

Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

Title: NC03996 - Nicotiana Leaf Surface Chemistry

Project Leader: David A. Danehower

I. Summary of Research:

The objectives of this research program during the past year have included:

a) development of rapid preparative and analytical systems for leaf surface constituents

b) cooperative studies with plant pathologists aimed at the determination of biological activity of tobacco leaf surface constituents against Peronospora tabacina (blue mold)

c) further studies of the effects of leaf surface compounds on the germination and growth of weed species in cooperation with weed scientists

d) analyses of tobaccos for the production of particular leaf surface components of importance to the production of tobaccos with unique flavor properties in cooperation with a tobacco breeder.

The specific experiments designed to meet these objectives have included the following:

1. Preparative Isolations of Tobacco Leaf Surface Constituents (with David Lawson)

This project was begun in 1986 and has resulted in the development of a complete preparative system for the rapid isolation of the principal leaf surface components of tobacco. The system allows individuals with a minimum of chromatographic equipment or skills to isolate tobacco leaf surface compounds in high yield in a short period of time. A brief description of the system is outlined below. For more complete details researchers can contact the principal investigator.

a) Isolation of Crude Leaf Surface Materials

The cultivar Galpao comun was chosen as the source of the crude leaf surface washes as it contains all of the principle components in relatively high quantities. The exception to this are alpha- and beta-duvatriene monols, which occur only in small amounts in this tobacco. Those researchers needing to isolate significant quantities of these constituents should use the Tobacco Introduction 1223.

Bud leaves and/or suckers provide the richest source of undegraded leaf surface compounds. These plant parts are harvested and subjected to a wash with methylene chloride using a large Buchner funnel. A brief dip into a beaker containing methylene chloride will also surfice to remove the leaf surface compounds. Following filtration, the resulting

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extract is evaporated under vacuum and stored as a concentrated solution at -78 degrees C until needed.

b) Fractionation into Component Classes

The crude extract is first subjected to fractionation using a Sephadex LH-20 column (dimensions approximately 25 x 60 cm) and a low pressure pumping sysem. The sample is injected as a 300 mg per ml solution in methylene chloride in a total volume of 10 ml. The compounds are eluted as component classes in order of increasing polarity using a solvent system composed of 99:1 methylene chloride:methanol at 5 ml per minute. Fractions are collected in 5 ml aliquots for 150 minutes, the eluting solvent is changed to 97:3 methylene chloride:methanol and an additional volume of 500 ml of elute is collected as a single fraction. The fractions are analyzed by thin layer (Merck silica gel 60 F-254, underivatized samples) and gas chromatography of silylated derivatives, pooled according to composition and reduced to dryness under vacuum. The resulting materials are redissolved in methylene chloride and stored as before.

c) Isolation of Z-Abienol and α- and β-4,8,13-duvatriene-1-ols

The mixture of Z-abienol and duvatriene-i-ols are applied to a column of Merck silica gel 60 (2.5 x 21.5 cm) in a 1 ml volume at a concentration of 100 mg per ml. The column is then eluted with a solvent system consisting of a 7:3 methylene chloride:hexane at a flow rate of 4 ml/min. Eighty, 5 ml fractions were collected, analyzed for purity by thin layer and gas chromatography as described earlier, and combined prior to evaporation under vacuum.

d) Isolation of α- and β-4,8,13-duvatriene-1,3-diols

The mixture of these isomers obtained by the Sephadex procedure was chromatographed on a column of Merck silica gel (2.5 x 21.5 cm) as a 100 mg/ml mixture in an injection volume of 1.0 ml. The solvent system in this separation consisted of a 1:1:8 ternary solvent mixture containing isopropanol:chloroform:hexane. Again, eighty 5 ml fractions were collected, analyzed as before, and pooled based upon their purity.

e) Isolation of Sucrose Ester Groups I-VI

The sucrose esters represent a complex mixture of closely related compounds which are unique to tobacco and the Nicotiana species. The resolution of this mixture into the individual classes is accomplished by high performance liquid chromatography using a Whatman Magnum 20 preparative reversed phase column (2.0 x 50 cm). The crude sucrose ester mixture obtained from the Sephadex LH-20 fractionation is applied as a 125 mg/ml solution in methylene chloride in an injection volume of 1 ml. The sample is eluted with a solvent system consisting of 6:4 acetonitrile:water at a flow rate of 5 ml/minute. Fractions are collected in 5 ml aliquots, analyzed as before and pooled into their respective classes. Group V esters are obtained in a purity of > 98% and the purity of other fractions is not less than 65%. Further purification can be achieved at the expense of yield by taking "heart-

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cuts" in this isolation procedure.

2. Rapid System for the Analysis of Tobacco Leaf Surface Compounds (with David Lawson)

The objective of this work has been the development of a procedure for the rapid screening of large quantities of plant samples for the presence of leaf surface compounds of interest. The following is a brief description of the procedure.

A total of 18 leaf disks are taken using a stainless steel punch and processed as described in a recent publication (Danehower, Tob. Sci. 31:32-35, 1987). The resulting extracts and appropriate standards (obtained using the preparative procedures outlined above) are then applied to Analtech silica gel G precoated thin layer plates using a 1 microliter pipette. The plates are developed in a solvent system consisting of a 7:8:6:79 mixture of Isopropanol:chloroform:methylene chloride:hexane. A single development is sufficient for resolution of virtually all component classes.

After development, the leaf surface compounds can either be detected directly by means of their UV absorption characteristics (in the case of the duvanediols, duvane monols, or Z-abienol) or by application of fuming sulfuric acid followed by subsequent heating which results in carbonization of all the leaf surface constituents present and their appearance as dark spots on a white background, the plates are then scanned using a Camag thin layer densitometer at either 200 nanometers (UV absorbing compounds) or in white light (charred spots).

Results of these experiments indicate that excellent results can be obtained for the analysis of the duvanes and Z-abienol using in situ UV detection. For the other components (hydrocarbons, wax esters, fatty alcohols, and sucrose esters) the charring procedure is preferable. The sucrose esters are a particularly difficult group to quantitate and the use of colorimetric reagents for their detection and quantitation are being investigated. An excellent curvilinear relationship between component mass and response has been demonstrated over a range of sample masses. We anticipate the application of this method in routine screening procedures during the coming growing season.

3. The Influence of Tobacco Leaf Surface Compounds on the Germination of Peronospora tabacina (Blue Mold) Conidia (with Mary Menetrez and Harvey Spurr, Plant Physiologist and Pathologist, USDA, Oxford Tobacco Research Station)

The potential significance of tobacco leaf surface compounds in the resistance of the plant to blue mold has been a subject of ongoing interest to tobacco pathologists for some time. The objective of this cooperative project (with Dr. Mary Menetrez and Dr. Harvey Spurr of the Oxford Tobacco Research Lab) has been the further assessment of the influence of these compounds on the germination of conidia (spores) of this important pathogen. The preparative chromatographic procedures described above were utilized in the isolation of quantities of the leaf surface compounds in quantities sufficient for bioassay of their ger-

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mination inhibiting properties. The results of these assays indicated that the duvanediols and Z-abienol significantly inhibited the germination of blue mold spores at concentrations of 50 ppm. The alpha isomer of the duvanediols was slightly more inhibitory than the beta isomer. The sucrose esters showed some very slight inhibitory activity at 50 ppm. Hydrocarbons were inactive at all concentrations tested. An interesting phenomenon was observed at lower concentrations. At 0.0005, 0.005, 0.05, and 0.5 ppm the spore germination percentage was actually enhanced (approximately 10%) above that of controls. This was true for virtually all the surface components tested.

4. The Effect of Tobacco Leaf Surface Chemicals on the Growth of Two Weed Species (with Donn G. Shilling, Weed Scientist, University of Florida)

In this set of experiments, the leaf surface compounds isolated by means of the preparative chromatographic procedures were tested against two representative weed species: barnyard grass (monocot) and hemp sesbania (dicot). The chemicals were applied to the seed as serial dilutions in 15 mM MES buffer. The seed were contained in a sterile glass container which was then covered and incubated in a growth chamber with a 12 hour photoperiod and a 28/23 degree C day/night temperature regime. The effects of the chemicals were evaluated at 84 hours. The results were expressed as percent inhibition of either total fresh weight (TFW) or of the predicted shoot-plus-root fresh weight (PSRFW) as determined from a previous set of experiments (Shilling et al. ACS Symposium Series No. 330, AM. Chem. Soc. Washington, D.C. 1987, p. 334). The results of the analysis of the purified leaf surface components is shown in Table I. The results of testing of the Sephadex fractions were presented in a table in last year's annual report.

5. Analysis of Tobacco Leaf Surface Compounds Important to Flavor and Aroma (with E. A. Wernsman, Tobacco Geneticist, Department of Crop Science, NCSU)

This is a continuing project aimed at the screening of tobacco germplasm for increased levels or unusual combinations of leaf surface constituents, which are important contributors to the characteristic flavor and aroma of tobacco products. The initial focus of the project was that introduction of the gene(s) for production of Z-abienol into flue-cured and burley tobaccos. The project during the last year has expanded to examine the possibility of introducing other chemical traits into flue-cured or burley types in combinations not presently available. This would include such combinations as a duvanediol Z-abienol producer, a duvanediol-sucrose ester producer, a Z-abienol-sucrose ester producer, or tobaccos which produce all three components. In particular, we have been interested in the isolation of tobaccos which are producers of Z-abienol but not sucrose esters, as these two chemical traits seem to be tightly linked genetically.

II. Graduate Students:

David R. Lawson, Masters Candidate. Thesis title: Chromatographic Isolation and Analyses of Nicotiana Leaf Surface Components. Date Completed: May, 1988.

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Table I. The effect of compounds isolated from Nicotiana tobacum on the growth of barnyardgrass and hemp sesbania.

Compound	Concentration (ppm)	Barnyard Grass TFW[1]	Barnyard Grass PSRFW[2]	Hemp sesbania TFW	Hemp sesbania PSRFW
		% inhibition			
α & β duva-trienemonol	100	84±6.2[3]	36±12.1	14±5.3	19±6.2
	10	4±1.3	10± 4.8	7±2.3	10±4.1
	1	+13±4.2	+30± 9.8	2±0.8	4±1.1
	0.1	+8±2.6	+21± 7.6	0	0
Sucrose esters	$100^{4,5}$	34±9.2	64±12.4	19±3.4	26±5.8
	10^{4}	2±0.4	4± 1.1	14±4.3	20±3.6
	1	+12±2.1	+24± 9.3	4±1.2	5±1.8
	0.1	+15±3.4	+32± 6.1	0	0
β-duvatrienediol	$100^{4,5}$	39±5.1	70±14.1	16±4.8	23±7.8
	10^{4}	29±4.8	51±11.4	+5±1.8	+8±2.1
	1	19±3.1	30± 7.6	0	0
	0.1	9±1.1	23± 6.8	0	0
α-duvatrienediol	$100^{4,5}$	32±7.2	50±11.6	11±2.6	18±3.9
	10	16±4.9	30±10.3	+1±0.2	+2±0.7
	1	3±0.8	5± 1.6	+14±3.1	+22±6.1
	0.1	+6±0.9	+16± 9.8	0	0
Hydrocarbons	100	6±2.1	13± 3.6	8±2.4	16±6.1
	10	+6±1.8	+14± 4.1	4±1.6	8±2.1
	1	+10±2.9	+20± 8.7	0	0
	0.1	+16±2.1	+37± 9.8	0	0
z-abienol	100	21±8.3	30± 9.4	5±1.8	8±2.4
	10	11±3.9	16± 2.9	2±0.9	5±1.9
	1	6±2.1	12± 4.3	0	0
	0.1	+8±3.6	+28±11.4	0	0

[1] Total fresh weight

[2] Predicted shoot-plus-root fresh weight.

[3] Mean values are followed by standard deviations. Any positive values (+) represent growth stimulation.

[4] Bleaching of shoot tissue in barnyardgrass.

[5] Total inhibition of root growth.

III. Post Doct

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V. Manuscripts

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itive values (+)

III. Post Doctoral Fellows:

None

IV. Publications:

Danehower, D. A. A rapid method for the isolation and analysis of the sucrose esters of tobacco. Tobacco Science 31:32-35. 1987.

Danehower, D. A., R. R. Izac, H. J. Grubbs, M. T. Core, and S. B. Hassam. A rapid method for the analysis of Z-abienol. Tobacco Science 31:38-51. 1987.

Brenizer, J. S., R. W. Jenkins, H. J. Grubbs, R. H. Newman, R. H. Bass, D. C. Jones, T. G. Williamson, D. A. Danehower, and R. C. Long. Distribution of selected inorganic elements in tobacco by instrumental neutron activitation analysis. J. of Radioanalytical and Nuclear Chemistry 113:477-485. 1987.

Lawson, D. R., D. A. Danehower, D. G. Shilling, M. Menetrez, and H. W. Spurr. Leaf surface allelochemistry of Nicotiana tabacum leaf surface compounds. 194th National American Chemical Society Meeting, New Orleans, LA. Aug. 30-Sept. 4, 1987. Division of Agrichemicals. Abstracts, p. 88.

Schell, L. P., D. A. Danehower, and J. R. Anderson. Application of high performance liquid chromatography to measurement of ATP levels in corn embryos germinated at optimum and sub-optimum temperatures. American Chemical Society 193rd National Meeting, Denver, CO., April 5-7, 1987. Division of Agriculture and Food. Abstracts, p. 13.

Menetrez, M., H. W. Spurr, D. A. Danehower, and D. R. Lawson. Toxicity of tobacco leaf surface chemicals to Peronospora tabacina. 41st Tobacco Chemists' Conference. Greensboro, NC. October 4-7, 1987. Abstracts #61.

V. Manuscripts Accepted for Publication:

Danehower, D. A., R. C. Long, M. T. Core, R. R. Izac, H. J. Grubbs. Changes in Z-abienol levels during growth, maturation, and curing of an oriental and a south american tobacco. Tobacco Science.

Lawson, D. R., D. A. Danehower, D. G. Shilling, M. Menetrez, and H. W. Spurr. Leaf surface allelochemistry of Nicotiana tabacum leaf surface compounds. In: Natural products for use in agriculture. H. G. Culter, editor. American Chemical Soc. Symposium Series.

Jenkins, R. W., H. J. Grubbs, R. H. Newman, R. H. Bass, J. S. Brenizer, D. C. Jones, T. G. Williamson, D. A. Danehower, and R. C. Long. Distribution of selected inorganic elements within the leaf of cured bright tobacco. Tobacco Science.

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VII. Papers Presented at Professional Meetings:

Lawson, D. R., D. A. Danehower, D. G. Shilling, M. Menetrez, and H. W. Spurr. Leaf surface allelochemistry of Nicotiana tabacum leaf surface compounds. 194th National American Chemical Society Meeting New Orleans, LA. Aug. 30-Sept. 4, 1987. Division of Agrichemicals.

Menetrez, M., H. W. Spurr, D. A. Danehower, and D. R. Lawson. Toxicity of tobacco leaf surface chemicals to Peronospora tabacina. 41st Tobacco Chemists Research Conference, Greensboro, NC. October 4-7, 1987.

Schell, L. P., D. A. Danehower, and J. R. Anderson. Application of high performance liquid chromatography to measurement of ATP levels in corn embryos germinated at optimum and sub-optimum temperatures. American Chemical Society 193rd National Meeting,, Denver, CO. April 5-7, 1987. Division of Agriculture and Food.

Danehower, D. A. Leaf surface chemistry of tobacco. Invited seminar: Philip-MOrris Research Center, Richmond, VA. Sept. 23, 1987.

Jenkins, R. W., H. J. Grubbs, R. H. Newman, R. H. Bass, J. S. Brenizer, D. C. Jones. T. G. Williamson, D. A. Danehower, and R. C. Long. Distribution of selected inorganic elements within the leaf of cured bright tobacco. 41st Tobacco Chemists Research Conference, Greensboro, NC. October 4-7, 1987.

IX. Acknowledgements:

The project leader would like to acknowledge the able assistance of Mr. David R. Lawson, Mr. Albert T. Butler, Ms. Marie Hall, Ms. Sarah Gay, and Mr. John C. Weeks in conducting portions of the research discussed. Special appreciation is extended to Doctors R. C. Long, E. A. Wernsman, W. W. Weeks, Mary Menetrez, H. W. Spurr, D. G. Shilling and Sandra Reed for their assistance and support in the conduct of the collaborative research efforts.

Title: NC03837

Project Leader:

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Title: NC03837 Chemical Evaluation of Volatile Compounds from Tobaccos Genetically Regulated for Alkaloids

Project Leader: W. W. Weeks

Flue-cured tobacco is characterized by unique aroma that differs from all other tobacco types. Although the volatile constituents responsible for flue-cured aroma are much lower in concentration than alkaloids and reducing sugars, these compounds are essential. Volatile compounds found in tobacco are comparable to those found in cooked foods, beverages, fresh fruits, and vegetables. These compounds transfer directly from tobacco to smoke. Smoke is described in strength and character. Character is frequently referred to as body resulting from the tobaccos comprising the cigarette blend. Rich full flavored cigarettes consist of 35 to 55% flue-cured tobacco that is rich in flue-cured character. Tobaccos that have desirable aroma also have factors that attract bugs. Aroma is greatly reduced by overheating and drying resulting in over curing - especially of good ripe tobacco. Curing tobacco requires experience as well as knowledge about tobacco but curing does not make good tobacco - it must be grown. Curing, however, optimizes tobacco quality. The farmer deals with that manipulation of curing parameters in certain circumstances and definitely improves tobacco quality.

The objective of this study was to attempt to cure flue-cured tobacco by controlling temperature and humidity. This would purposely increase the concentration of tobacco volatiles predominantly terpenes and terpenones while at the same time produce tobacco with sufficient amounts of reducing sugars for flue-cured tobacco. Properly yellowing tobacco and inducing starch hydrolysis produces reducing sugars which are further preserved by drying and killing enzyme activity.

Three heat treatments were imposed upon five primings of Speight G-28. The treatments were carried out simultaneously in three bulk curing units at Oxford, North Carolina. The tobacco was subjected to yellowing and when the tobacco was determined yellowed the temperature was increased rapidly to 100, 120, and 160 degrees fahrenheit very rapidly. The temperatures were held constantly until completely dry. The 100 degree temperature regime required over 21 days to completely dry. The tobacco from this treatment was surprisingly better than expected in looks. The 160 degree cure looked and felt like a regular conventional cure. There were differences in filling capacity between the three tobaccos. The tobacco cured at higher temperatures exhibited higher filling capabilities or lower density tobacco. Chemical analyses were obtained only for primings B, C, D, and E (Table I).

The samples were extracted and measured chromatographically for neutral volatiles. The sum of specific volatiles that are identified and correlated for flue-cured aroma and taste were quantified and shown in Table II. Figure I demonstrates chromatographic differences in curing from priming E. The quantitative results are consistent from priming to priming; however, it is very difficult to explain why the higher temperature regime, 160 degrees, produced higher concentrations of volatiles than the 120 degree treatment. The tobaccos cured at higher temperatures exhibited flashier colors and were somewhat bulkier than the other treatments.

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The 100 degree treatment in all cases produced tobacco with considerably more measurable aroma. This has been demonstrated to produce more flue-cured character when used as smoking tobacco. The tobacco was not made into smoking tobacco and that needs to be done. Since this was primarily a trial experiment, there were no replications of primings but the same trends for each priming was observed particularly for the lower temperature. This regime was also the only treatment that demonstrated a stalk position effect in chemistry. This was also represented in price per 100 wt. for the tobacco as well.

CHEMICAL DATA

Table I
% Total Alkaloids and Reducing Sugar

Priming	Temperature	Alkaloids	Reducing Sugar
B-1	160°	3.50	17.6
B-2	120°	3.35	18.0
B-3	100°	3.33	16.2
C-1	160°	3.48	19.8
C-2	120°	3.69	16.6
C-3	100°	3.54	14.5
D-1	160°	3.59	19.8
D-2	120°	3.62	18.1
D-3	100°	3.61	18.1
E-1	160°	3.74	18.0
E-2	120°	3.78	19.5
E-3	100°	3.48	17.7

$\bar{x}$ sugar 17.82
Sd = 1.54

$\bar{x}$ alkaloids 3.56
Sd = 0.14

Table II.

Total Volatiles µg/gm obtained from distillation of 10 gm samples from different primings.

Primings	Curing Temperature		
	160°	120°	100°
B	298	181	317
C	283	245	406
D	335	289	525
E	523	295	687

CHROMATOGRAPHIC PROFILES OF E PRIMING AT 3 TEMPERATURES

FIG. 1

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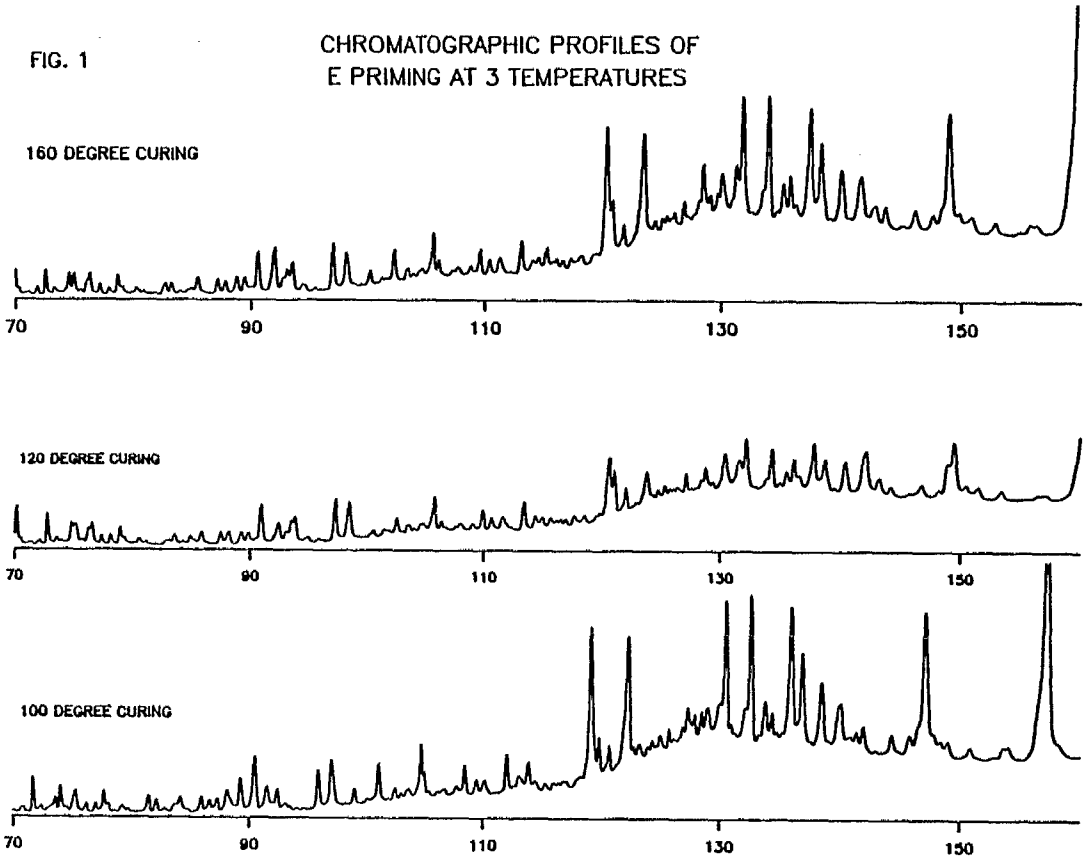

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Title: NC05149 - Analytical Methodologies Required for Chemical Analyses to Experimental Tobaccos

Project Leader: W. W. Weeks

The tobacco analytical laboratory is currently completing tobacco analyses for the 1987 crop. This is the second season the laboratory has functioned with a computerized data system and the first year we have used a digital balance interphased with the data system. Although the tobacco season was later than usual due to the dry season and late maturing tobacco from several of the experiment stations, the laboratory has completed 11,000 samples from the 1987 crop. These samples were submitted by project leaders from six different departments. There are still over 1,000 samples to be analyzed, but they are samples with low priority.

The data from this year's crop has been very difficult to analyze because of the high alkaloid levels from the dry season that occured in 1987. Other analyses the laboratory performs were affected adversely by the drought as well but not in the same manner as total alkaloids.

There has been an increase in the number of burley samples submitted for analyses this year over prior years. Nicotine in this year's burley crop has been extremely high for all locations the laboratory has analyzed. Breeding material submitted for analyses have exceeded 6 and 7 percent. Project leaders that have submitted burley samples by stalk position have learned little because the analyses do not appear to demonstrate a stalk position effect.

Graduate Students:

Zhimin Wu - Tobacco volatiles and smoking quality of flue-cured tobacco and other tobacco types grown in North Carolina.

Inigo Pfeiffer - Chemical and sensory evaluation of flue-cured tobacco varieties that exhibit different quality.

Papers Presented at Professional Meetings:

Weeks, W. W. (N. C. State University) E. D. Alford, J. H. Zauterbach (Brown & Williamson Tobacco Company). Gas chromatography-mass spectrometry studies on popular old and new flue-cured varieties. Tobacco Chemists' Research Conference, Greensboro, NC. October 4-7, 1987.

Weeks, W. W, R. C. Long. Effects of air- and flue-curing on neutral volatiles and sensory evaluation of several tobacco types. Tobacco Chemists' Research Conference, Greensboro, NC. October 4-7, 1987.

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Title: Burley Tobacco On-Farm Tests

Project Leaders: R. L. Davis

I. Summary of Research:

This project has the following objectives.

A. To evaluate the performance of available burley varieties and hybrids under the varying conditions that occur in the mountains of western North Carolina.

B. To test rates, timing, tank mixes, sequential applications, and combinations of labeled sucker control chemicals on burley tobacco.

C. To evaluate the use of supplemental heat in curing burley tobacco.

D. Summary of results obtained with no-till burley production and results obtained with burley herbicides in the Weed Science section of the report.

BURLEY TOBACCO ON-FARM TEST RESULTS 1987

Drought conditions persisted through most of the 1987 growing season. This is the third straight droughty season in the burley area of western North Carolina. Some communities in the burley area are experiencing the driest three-year continuous period since weather records have been kept. This is true even though some sections have had enough rainfall during the growing season to produce near normal yields. The overall dry period has affected the cure and the quality to a market extent. Early transplanted tobacco cured well and sold well while later set tobacco cured poorly with a substantial portion of the leaf being variegated or green in color which dropped sharply in price.

BURLEY ON-FARM VARIETY TESTS

Acre yields and value data for five tests are given in the accompanying table. The overall yield was very good considering the severity of the drought. Selling price was also good. Tests at two other sites, however, were abandoned for experimental purposes due to uneven growth as a result of the drought.

Differences in yield among the varieties and hybrids tested were not as great as is sometimes observed in other seasons when growing conditions are more favorable.

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Prices per cwt. has been generally similar for all varieties and hybrids tested over the past several seasons.

BURLEY VARIETIES 1987
AVERAGES FOR 5 TESTS

Treatment	Acre Yield	$ Cwt	$ Acre
1. Ky 14	2647	155.57	4122
2. Va 509	2639	155.74	4110
3. Bu 21 x Ky 10	2715	155.83	4231
4. R 7-11	2768	156.31	4327
5. C-501	2326	155.19	3612
*			
7. Ky 14 x L8	2627	155.92	4099
8. Tn 86	2563	156.49	4013
9. Bu 21 x Ky 14	2578	156.43	4033
10. Ky 17	2458	155.39	3820

* No Treatment 6.

SUCKER CONTROL 1987

All of the labeled sucker control chemicals are used in these tests. These include several brand name products of maleic hydrazide and contacts and also FST-7 and Prime +. Most on-farm test work deals with timing, rates, sequential applications, and tank mixes. All treatments are checked for efficacy.

The weight of suckers produced per plant in 1987 was quite low as a result of the dry season. Control is usually more difficult on drought-stressed tobacco. Maleic hydrazide appears to be absorbed into the plant more slowly and less efficiently. The contact type materials are more difficult to apply with a boom type sprayer as wilted leaves will not gather spray material and funnel it toward the stalk as efficiently as upright leaves. An example is Treatment 3 in the Code 1 tests where 99% control was obtained with Prime + when a dropline was used, but the same

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chemical gave only 82% control (Treatment 6) when a boom was used. Under extremely dry conditions, better results seem to be obtained if spraying is carried out early in the day before leaves begin to wilt and droop. However, avoid spraying when leaves are covered with a heavy dew as spray material will puddle and cause leaves to drip and waste part of the chemical.

The most consistently successful treatment in these tests over a period of years has been a sequential application involving a contact applied at the button stage followed by topping about a week later and the application of either maleic hydrazide or FST-7. If properly timed, this method will control both pre- and post-topping suckers and will last up to six weeks after topping. Straight contacts alone are not usually successful.

One application of MH will normally control suckers in the mountain area for about 28 days plus or minus two or three days. If control does break down, suckers will come from top to bottom on the plant.

Prime + has the longest period of control of the presently available chemicals but escapes are still a problem. Tank mixes show some promise of avoiding escapes and a sequential application has been added to the Prime + label. Observe caution statement on the label for carryover effects of Prime +.

Results of 1987 tests are given in the tables.

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SUCKER CONTROL 1987
CODE 1 - AVERAGES FOR 3 TESTS

Treatment	% Control	Suckers No./Pl	Green Wt. Gms./Pl	Acre Yield	$ Cwt	$ Acre
1. TNS	--	7.9	411	2066	146.45	2991
2. RMH-30 @ 1 GPA plus) Prime + @ 1/2 GPA) tank mix	99	0.2	3	2262	148.79	3338
3. Prime + @ 1 GPA (Dropline)	99	0.1	2	2512	148.10	3692
4. Super Sucker Stuff @ 1 GPA	98	0.9	13	2551	147.23	3715
5. Fair 85 @ 1.5 GPA button plus FST-7 @ 2 GPA at topping	98	0.2	6	2529	149.32	3772
6. Prime + @ 1 GPA (boom)	82	0.9	73	2537	146.60	3694
7. OST @ 1.5 GPA button OST @ 1.5 GPA at topping	63	3.2	149	2010	146.58	2933
8. FST-7 @ 3 GPA	99	0.3	4	2238	148.49	3286

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SUCKER CONTROL 1987
CODE 2 - AVERAGES FOR 3 TESTS

Treatment	% Control	Suckers No./Pl	Green Wt. Gms./Pl	Acre Yield	$ Cwt	$ Acre
1. TNS	---	8.1	89	1969	153.03	3031
2. Super Sucker Stuff @ 1/2 GPA) tank plus Prime + @ 1/2 GPA) mix	100	0	0	2159	151.99	3308
3. OST @ 1.5 GPA plus) Prime + @ 1/2 GPA)tank mix	100	0	0	2103	152.70	3233
4. Fair 2 @ 1.5 GPA	100	0	0	2152	153.89	3321
5. Sucker Plucker @ 1.5 GPA button plus SSS @ 1 GPA at topping	100	0	0	1984	151.73	3039
6. Prime + @ 1 GPA	100	0	0	2143	152.21	3277
7. OST @ 1.5 GPA button plus RMH-30 @ 2 GPA at topping	100	0	0	2084	152.05	3196
8. FST-7 @ 9 Quarts/A	100	0	0	2144	152.83	3295

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SUCKER CONTROL 1987
CODE 3 - AVERAGE FOR ONE TEST

Treatment	% Control	Suckers No./Pl	Green Wt. Gms./Pl	Acre Yield	$ Cwt	$ Acre
1. TNS	---	6.8	172	2394	156.11	3737
2. Fair + @ 1 GPA))tank mix Prime + @ 1/2 GPA)	100	0	0	2779	156.50	4350
3. OST @ 1.5 GPA button OST @ 1.5 GPA at topping	69	2.8	53	2743	156.50	4292
4. RMH-30 @ 2 GPA	100	0	0	2557	156.82	4010
5. Fair 85 @ 1.5 GPA button FST-7 @ 2 GPA at topping	100	0	0	2498	156.44	3907
6. Prime + @ 1 GPA	83	1.2	29	2461	156.18	3844
7. Fair 85 @ 1.5 GPA button Fair + @ 2 GPA at topping	100	0	0	2656	156.45	4155
8. Super Sucker Stuff @ 1 GPA	99	0.3	1	2670	156.71	4186

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CURING WITH SUPPLEMENTAL HEAT 1987

Burley tobacco cures best when humidity is in the general range of 65-70% and the temperature is between 60-90 degrees fahrenheit. Traditionally, the worst curing problem in western North Carolina burley has been houseburn. This occurs when the humidity remains at or near 100% for a period longer than 24 hours. These conditions prevail during a period of rainy, damp, foggy weather. Houseburn is caused by several species of bacteria and fungi that are always present of the leaves of a normal tobacco crop. These organisms require moist conditions for an extended period before their numbers build up to a level that can cause significant damage to the curing leaves. Under average conditions, the humidity within a curing barn will approach 100% each night for the first two or three weeks after the barn is filled. If enough ventilation is provided to dry the barn out the next day, very little damage is seen. The judicious use of supplemental heat during wet weather will lower the humidity within the barn enough to prevent serious damage.

The 1987 season was extremely dry with the drought extending on through curing. Humidity was lower than optimum through much of the cure with the leaf drying too fast. This resulted in variegated, mottled and green color in leaf from a significant portion of the crop.

Supplemental heat was used very little for either of the two curing tests in 1987. Acre yields and values obtained with and without heat are given in the table.

CURING WITH SUPPLEMENTAL HEAT 1987
2 LOCATIONS

Treatment	Acre Yield	$/Cwt.	$/Acre
Heat	2304	151.59	3488
No Heat	2371	148.22	3488

IV. Publications:
Davis, R. L. (+ 20 authors). 1988 Burley Tobacco Information Ag-376, Jan. 88. 85 pp.

IX. Acknowledgments:
Thanks is extended to Mr. D. S. Whitley for Technical assistance.

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Title: An Empirical Analysis of Seasonal Labor Costs and the Impact of Recent Changes in Federal Regulations: with Consideration of the Effects on Structural Issues (a Tobacco Foundation Project)

Project Leader: Daniel A. Sumner and Steven G. Allen

I. Summary of Research:

This project is developing a survey data base to use to study the labor demand and related practices of flue-cured tobacco growers. Recent changes in immigration laws and sanitation regulations suggest that this is a useful time to investigate tobacco labor markets.

A survey questionnaire was developed and pretested in the fall so that it could be mailed in January to flue-cured tobacco growers in 18 major counties in North Carolina. Growers were asked some basic background data about their farms, tobacco enterprises and their family labor situation. Specific questions were included about hire labor use and expenditures, technology, and planned changes. Responses to the questionnaire are currently being received, edited and tabulated. Estimation of labor demand and effects of public policy will use the 1988 data and that of a follow up survey next year.

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Title: NC 13943 Effects of Farm Programs on Prices, Quantities and Incomes of Field Crop Producers and Consumers

Project Leader: Daniel A. Sumner and Randal R. Rucker

I. Summary of Research:

A survey of county flue-cured tobacco quota sales prices and lease rates for 1986 was conducted and information put together with data from earlier years. These data are used in the estimation of the derived demand elasticity of quota and the implied supply elasticity.

A theoretical model was developed to analyze the effects of the tobacco program on the variability of prices, incomes, quantities and other relevant variables affecting the tobacco industry. Results of examining the recent variability at the industry and county levels for North Carolina flue-cured tobacco and Maryland tobacco suggests that while the program reduces price variability it induces quantity variations and variability in lease rates so that it may have relatively little effect on net revenue variability.

IV. Publications:

Daniel A. Sumner and Julian M. Alston. "Substitutability for Farm Commodities: The Demand for U.S. Tobacco in Cigarette Manufacturing," American Journal of Agricultural Economics, 69(2):258-265.

Daniel A. Sumner. "The Budget Costs of a 'No Net Cost' Tobacco Program," Current Issues in Tobacco Economics, ed. Farrell Delman. Princeton, NJ: Tobacco Merchants Association of the U.S., pp. 151-175. 1987.

V. Manuscripts Accepted for Publication:

Daniel A. Sumner. "Stability and The Tobacco Program," in Agricultural Stability and Farm Programs, edited by Daniel A. Sumner, in press. Westview Press, 1988.

VI. Manuscripts in Review:

Julian M. Alston and Daniel A. Sumner. "Consequences of Regulatory Change in the Tobacco Industry," submitted to a refereed journal. December 1987 and currently under review.

VII. Papers Presented at Professional Meetings:

Barry K. Goodwin, Daniel A. Sumner and D. Arthur Sparrow. "Identification and Estimation of Underlying Market Supply Function Parameters for a Commodity with Mandatory Output Controls," presented at AAEA meetings August 1987, forthcoming abstract in AJAE, December 1987.

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Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

Title: NC 03835 Explanation of Size Distributions of Farms: Economic Models and Empirical Applications

Project Leader: Daniel A. Sumner

I. Summary of Research:

Work on this project is closely related to other research on farm size supported by The Tobacco Foundation and a USDA Cooperative Agreement. Specific titles of the projects funded by latter sources are (1) Explanation of Size and Structure in Tobacco Farming and (2) Effects of Farm Programs on Farm Size and Structure in the Tobacco and Peanut Industries. In this work a dynamic programming model of changes in farm size behavior in a stochastic environment was developed that is applicable for analyzing changes in size of tobacco or other kinds of farms. The model derives potentially estimable differential equations for farm size changes from optimizing behavior. Another research aspect is empirical analysis of tie-in sales contracting practices for quota and nonquota peanuts that is related to potential changes in the structure and size distribution of peanut farms.

II. Graduate Students: David A. McDonald

IV. Publications:

Daniel A. Sumner and James D. Leiby. "An Econometric Analysis of the Effects of Human Capital on Size and Growth Among Dairy Farms," American Journal of Agricultural Economics, 69(2):465-470. May 1987.

VII. Papers Presented at Professional Meetings:

James D. Leiby and Daniel A. Sumner, "A Model and Econometric Analysis of Farm Size and Growth," presented at the AAEA meetings, East Lansing Michigan, August 1987.

Daniel A. Sumner and Stephen E. Margolis. "Tie-In Sales in Peanut Contracting: An Economic Analysis of a Marketing Puzzle," presented at AAEA meetings, August 1987.

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Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

Title: NC 02149 Analysis of International Trade Policies

Project Leaders: Paul R. Johnson

I. Summary of Research:

The tobacco aspect of this project is currently the economic aspects of the quality of tobacco. The quality issue affects the quantity of flue-cured tobacco imported into the U.S. as well as U.S. exports of flue-cured tobacco. The work is still incomplete. Preliminary regression analysis indicates that price relationships are still the most important determinant of the amount of flue-cured tobacco going into stabilization.

Recent data also indicate that there has been some change in buyers' views of different grades of tobacco. That is, a disproportionate amount of certain grades have gone to stabilization.

IV. Publications:

JOHNSON, P.R. 1987. Agricultural Trade Issues. Looking Ahead. Volume IX, no. 4.

JOHNSON, P.R. 1987. U.S.-Canadian Trade in Specialty Products.(the tobacco section) in Agricultural Trade Between the United States and Canada, National Public Policy Education Committee.

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Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

Title: Biology, Ecology and Management of Insects in Tobacco: NC03983

Project Leader: Emmett P. Lampert

I. Summary of Research:

A. Evaluation of Insecticides for Control of Insect Pests

The objectives of these experiments were to evaluate candidate insecticides for 1) efficacy against various soil and foliar insect pests, 2) phytotoxic symptoms when applied alone and in mixes, and 3) effects on yield and quality of tobacco.

Experiments were conducted at the Border Belt Tobacco Research Station (BBTRS) and the Central Crops Research Station (CCRS) to determine the efficacy of various soil-applied and foliar-applied insecticides against tobacco wireworms, tobacco flea beetles, green peach aphids, tobacco budworms, and tobacco hornworms on flue-cured tobacco. Soil insecticide tests were conducted at the BBTRS, while foliar-applied tests were conducted at both the BBTRS and CCRS. At the BBTRS, a 10-treatment soil-insecticide test was designed to determine the efficacy of selected preplant-incorporated pesticides against tobacco wireworms and green peach aphids. An additional six-treatment foliar-applied test was designed to evaluate the efficacy of foliar applications of Karate 1E, Orthene TIS, and Orthene TIS plus a feeding adjuvant against tobacco budworms.

At the CCRS, five foliar-applied insecticide tests were conducted. These tests were primarily designed to determine the efficacy of candidate insecticides against tobacco budworms and to a lesser extent, tobacco hornworms. One test was designed to evaluate commonly used aphid-insecticides against the red color form of the green peach aphid. Orthene TIS and Thiodan 2EC were found to be more efficacious than Lannate or Azodrin, while malathion was no more efficacious than the untreated checks. Due to the bulk of the results of these experiments, the reader is referred to "Chemical Tests in Flue-Cured Tobacco, 1987" for specific material performance and test information.

B. Effects of Aphid Control on the Incidence of Viruses in Large-Field Plots (with G. V. Gooding, Jr.)

The objective of this project was to determine the effects of aphid control with acephate (Orthene TIS) on the incidence of potato virus Y (PVY) in flue-cured tobacco. Colonizing aphids were eliminated from the plots, leaving immigrating aphids as the primary source of vectors.

This research was conducted on excess allotment tobacco grown in Carteret Co., North Carolina. Carteret Co. was selected because of its history of high levels of PVY. Due to the possible effects of between plot contamination, large plots, separated by at least 50 yards, were used. Plots were 24 rows by 110 feet (0.28 acres or ca. 1200 tobacco

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plants, 'Coker 176') and were arranged in a randomized complete block design with two treatments and four blocks. 'Coker 176' was used because it is resistant to tobacco mosaic virus, the only other common tobacco virus in the county. The two treatments consisted of 1) aphid management (weekly treatment with Orthene TIS at 0.50 lb Ai/acre), and 2) no aphid management (untreated with aphidicides). Plots were monitored and when foliage feeding insects were at economic thresholds, they were treated with selective insecticides (budworms and hornworms were treated with Dipel 2X; flea beetles were treated with Sevin XLR). After transplanting (2 May 1987), the center four plants in each plot (the middle two plants in the center two rows) were replaced with four greenhouse grown transplants that had been inoculated with a local strain of PVY. Plots were monitored throughout the season, rated for aphid abundance, and surveyed for PVY infection. On all sample dates, aphid-infested and/or PVY-symptomatic plants were recorded by row and plant. At the end of the season, samples of symptomatic plants were serologically assayed for virus confirmation.

As the season progressed, the number of plants showing signs of PVY infection increased in both the aphid-treated plots (Fig. 1A), and the untreated plots (Fig. 1B). The spread of virus was not significantly different between the aphid-treated and untreated plots ($P > 0.05$). The proportion of plants colonized by aphids increased throughout the season in the untreated plots (Fig. 2A); whereas, very few aphids were allowed to build up in the treated plots between insecticide treatments (Fig. 2B). The exception was plot 8 on the final sample date (1 July) with about 40% of the plants colonized; however, the number of aphids per plant was low (usually < 10 aphids per plant) and represented a recent colonization.

This experiment has shown (for the third year) that the level of PVY in a tobacco field cannot be controlled through aphid control with acephate (a material that almost totally eliminated colonizing aphids from the plots). These findings support the hypothesis that PVY is transported into the field from external sources and/or that transient aphids are responsible for the spread of PVY in the environment tested. In either case, treatment for aphids in a field will not reduce virus incidence in that field. Further field experiments are planned to examine the effects of aphid-repellent insecticides (synthetic pyrethroids, i.e., Karate by ICI Americas Inc.) on the spread of PVY in tobacco. These insecticides have shown promise in reducing aphid probing in other crops thereby reducing virus acquisition and inoculation.

We feel this information is necessary for the development of sound management programs for aphid-vectored viruses in tobacco, as it is impractible to eliminate all external sources of both aphid vectors and/or viruses.

C. Effects of Host-Plant Health on the Bionomics of the Green Peach Aphid (with R. V. Wilfert Eckel, Ph.D. student)

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The objectives of this research were to determine the effects of 1) host plant health (healthy plants or plants infected with tobacco etch virus [TEV]), 2) age of TEV infection in the host plant, and 3) planting date, on the number of aphids alighting on tobacco. This research would supplement work conducted over the past two years investigating the interactions of aphids, viruses, and tobacco.

This research was conducted at the Central Crops Research Station (CCRS). Plots were 10 rows by 35 plants ('Coker 176'). The experiment was a 3 x 4 factorial design with no replication (Sokal and Rohlf 1969). Factors were planting date (4, 15, and 26 May) and inoculation date (healthy, and inoculated 2, 3, or 4 weeks after transplant). In inoculated plots, 18 uniformly distributed plants were mechanically inoculated with a nonaphid-transmissible (NAT) strain of TEV (Simons 1976) at the appropriate dates after transplant. Nine clear alighting traps were placed in each plot over either infected plants (in inoculated plots) or healthy plants (in non-inoculated plots). Trap placement maximized distance between the traps within each plot while avoiding the edges of plots by 7.5 ft. or more. Traps were maintained over a top leaf of the tobacco plants by periodic adjustment. Ethylene glycol was used in the traps as a preservative. Aphids were collected three times per week and stored in alcohol for future identification. Leaf area of 5 inoculated plants per plot (random plants in non-inoculated plots) were measured weekly (Suggs et al. 1960). Using the mean number of aphids caught per trap (ATC) and mean leaf area per plant, an estimate of the aphids alighting per plant (EAAPP) was made for each plot.

Analysis of variance showed no significant effect of inoculation date on ATC or EAAPP. The planting date had a moderate effect on these variables (week 4, 6, and 9). However, within a single planting date a distinct trend in aphid catch is indicated (Fig. 3). Chi-square analysis of these data indicate some significant differences in aphid catch trap due to TEV inoculation date (within a planting date).

Traps in inoculated plots generally collected more aphids than expected 2 to 5 weeks after inoculation. Analyses of EAAPP data shows more than the expected number of aphids alighted on inoculated plants 1 to 7 weeks after inoculation. In contrast, ATC and EAAPP in healthy plots are greater than expected 6 to 9 and 6 to 11 weeks after transplant, respectively.

We conclude that planting date and week of inoculation have a significant effect on alighting aphids. TEV-infected plants are somewhat more attractive than uninfected plants to alighting aphids 2-5 to 1-7 weeks after inoculation, depending upon planting date. Healthy plants, by comparison, are more attractive late in the growing season, 6-9 to 6-11 weeks after transplant. This would suggest that aphid vectors are alighting with greater frequency on TEV-infected plants early in the growing season, when virus spread is particularly important in the epidemiology of the disease.

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Identification of trapped aphids is continuing. When all aphids are identified, data will be further analyzed to evaluate the effects of planting date and week of infection on different aphid vector species.

References

Simons, J. N. 1976. Aphid transmission of a nonaphid-transmissible strain of tobacco etch virus. Phytopathology 66: 652-654.

Sokal, R. R. and F. J. Rohlf. 1969. Biometry. W. H. Freeman and Co. San Francisco, CA. 776 pp.

Suggs, C. W., J. F. Beeman, and W. E. Splinter. 1960. Physical properties of green Virginia-type tobacco leaves. III. Relation of leaf length and width to leaf area. Tob. Sci. 4: 194-197.

D. Mechanisms and Levels of Insecticide Resistance of Two Color Forms of the Green Peach Aphid on Tobacco (with Chris D. Harlow, M.S. student)

The objectives of this research were to identify a possible mechanism of insecticide resistance in the green and red forms of the green peach aphid and correlate this mechanism with differences in insecticide mortality associated with the aphids.

The laboratory portion of this work was conducted on the North Carolina State University campus, Method Road Complex, Unit 2. Aphids studied in the experiments were collected from five different locations in North Carolina and maintained in culture in the laboratory on flue-cured tobacco plants 'McNair 944'. Red and green aphids were collected from Carteret, Duplin, and Johnston counties; red only from Halifax and Lenoir counties; and green only from Johnston County. All aphids were collected in late summer, 1986, with the exception of the green only colony from Johnston County, which was collected in August 1983. Nine different colonies were examined in this study.

The study was divided into two experiments. The first experiment used an insecticide dip test to determine relative susceptibility of the aphids to the insecticide monocrotophos. Aphids were mounted on microscope slides on double-sided tape, then submerged into a 0.0013 g active ingredient/ml water solution of the insecticide for 15 seconds. Slides were hung vertically for 24 hours, then the number of living aphids was determined by probing lightly with a soft brush. An aphid was considered alive if its legs moved after being probed for no longer than 10 seconds. Aphids dipped in a water only solution at the same time were used as a control. Treatments were colonies, and a replication consisted of dipping no less than 15 aphids of each colony into the insecticide solution and no less than 10 aphids of each colony into the water. One replication was performed in a day. A total of 6 replications were performed for this experiment.

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The second experiment utilized an enzyme-substrate reaction to determine relative contents of total carboxylesterase (A.L. Devonshire, personal communication) in the same colonies of aphids. The substrate, 1-naphthyl acetate, was prepared in acetone. A homogenate of one aphid in a phosphate buffer was made, and a portion equivalent to one-half of one aphid was added to the substrate preparation. The enzyme-substrate reaction was allowed to proceed for 30 minutes, then stopped and a Fast Blue Salt added. Fifteen minutes later, absorbance at 605 nm by the solution was measured with a spectrophotometer. Higher absorbance indicated a greater content of the carboxylesterase. Again, treatments were colonies, and a replication consisted of one aphid from each colony plus an aphid-free buffer solution being run. From 1 to 3 replications were run in a day; 13 replications were run for this experiment.

The results from these experiments are represented graphically in Figures 4. Figure 4A shows differences in percent mortality to monocrotophos between the nine cultures (collection sites). Cultures with the same letter do not differ significantly in their susceptibility to the insecticide. Figure 4B shows relative differences in total carboxylesterase contents, expressed as absorbances, between the nine aphid cultures. Again, cultures with the same letter do not differ significantly in carboxylesterase content. The data suggest that increased carboxylesterase content may give rise to a higher level of insecticide tolerance in the green peach aphid; however, due to the general nature of the substrate used in the carboxylesterase determinations, there may be other mechanisms present. Further work is underway to pursue these possibilities and pinpoint the actual mechanism.

E. Separation of a Tobacco-Feeding Form of the Green Peach Aphid

Recently a tobacco-feeding form of the green peach aphid, Myzus persicae (Sulzer), has been identified and given a new species name, M. nicotianae Blackman (Blackman 1987). For consistency with existing proposals, I have continued to use the common name, green peach aphid, in this report. In the future, however, references will be to M. nicotianae. We believe the aphids we have been finding in tobacco have undoubtedly been this species all along, but have only now been distinguished as a separate species.

References

Blackman, R. L. 1987. Morphological discrimination of a tobacco-feeding form from Myzus persicae (Sulzer) (Hemiptera: Aphididae), and a key to New World Myzus (Nectarosiphon) species. Bull. Entomol. Res. 77: 713-730.

II. Graduate Students:

- Committee Chairman - Ms. Randi Wilfert Eckel (Ph.D. Co-Chairman)
- Mr. Christopher Harlow (M.S.)

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III. Postdoctoral Fellows: None

IV. Publications:

Lampert, E. P. and P. S. Southern. 1987. Evaluation of pesticide application methods for control of tobacco budworms (Lepidoptera: Noctuidae) in flue-cured tobacco. J. Econ. Entomol. 80:961-967.

Lampert, E. P. and Carla A. Dennis. 1987. Life history of two color morphs of the green peach aphid (Homoptera: Aphididae) on flue-cured tobacco. Tob. Sci. 31: 91-93.

Lampert, E. P. and A. S. Stephenson. 1987. Control of tobacco budworms with foliar insecticides, 1986. Insect. and Acar. Tests 12: 296-297.

Lampert, E. P. and A. S. Stephenson. 1987. Control of tobacco budworms with various formulations of Bacillus thuringiensis var. Kurstaki and acephate, 1986. Insect. and Acar. Tests 12: 294.

Lampert, E. P. and A. S. Stephenson. 1987. Control of wireworms and aphids with soil insecticides and nematicides, 1986. Insect. and Acar. Tests 12.: 295-296.

Southern P. S. and E. P. Lampert. 1987. Control to vegetable weevils with foliar insecticides, 1986. Insect. and Acar. Tests 12: 309.

Gray, S. M. and E. P. Lampert. 1988. Relationship between inoculum density and vector phenology on the incidence of potato virus Y in tobacco. Ann. Appl. Bio. 122: (in press).

V. Manuscripts Accepted for Publication:

Lampert, E. P., H. A. Smith and R. V. Wilfert Eckel. Relative efficiency of Myzus nicotianae as a vector of tobacco etch virus to tobacco and sicklepod. J. Agric. Entomol.

Lampert, E. P. Seasonal abundance and within-plant distribution of Myzus nicotianae (Homoptera: Aphididae) on flue-cured tobacco. J. Econ. Entomol.

Lampert, E. P. and A. S. Stephenson. Tobacco budworm control with various formulations of Bacillus thuringiesnsis, 1987. Insect. and Acar. Tests 13.

Lampert, E. P., A. S. Stephenson and P. S. Southern. Control of tobacco budworm with Bacillus thuringiensis and acephate alone and with entice, 1987. Insect. and Acar. Tests 13.

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Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

VI. Manuscripts in Review:

Lampert, E. P., H. A. Smith and G. V. Gooding, Jr. Transmission of potato virus Y and tobacco etch virus by red and green color forms of the green peach aphid (Homoptera: Aphididae). J. Econ. Entomol.

Lampert, E. P. and G. V. Gooding, Jr. Effects of control of Myzus nicotianae (Homoptera: Aphididae) on PVY incidence in tobacco. Crop Prot. (in departmental review)

VII. Presentations at Professional Meetings:

Wilfert, R. V. and E. P. Lampert. Spatial analysis of tobacco etch virus in tobacco. Poster Session, Annual Meeting Entomological Society of America. Boston, MA. 2 December 1987.

Lampert, E. P. Red-green peach aphid. Discussion Leader, Tobacco Seminar. Savannah, GA. 25 February 1988.

VIII. Graduate Student Thesis Completed During Reporting Period: None

IX. Acknowledgments:

I would like to acknowledge the technical assistance and support provided by Mr. Alan Stephenson and Mr. Lawrence Pearce, and the editorial and secretarial assistance provided by Ms. Connie Satterwhite. I would also like to thank the North Carolina Tobacco Foundation and the Agricultural Chemicals Industry for supporting much of the work conducted by my program. The cooperation and assistance provided by Mr. George Clark and Mr. Kimball Brock, Border Belt Tobacco Research Station, and Mr. Wallace Baker and Mr. Fred Smith, Central Crops Research Station, has greatly facilitated the performance and quality of this research.

VIRUS INCIDENCE (PROPORTION)

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Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

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Reporting Period: None

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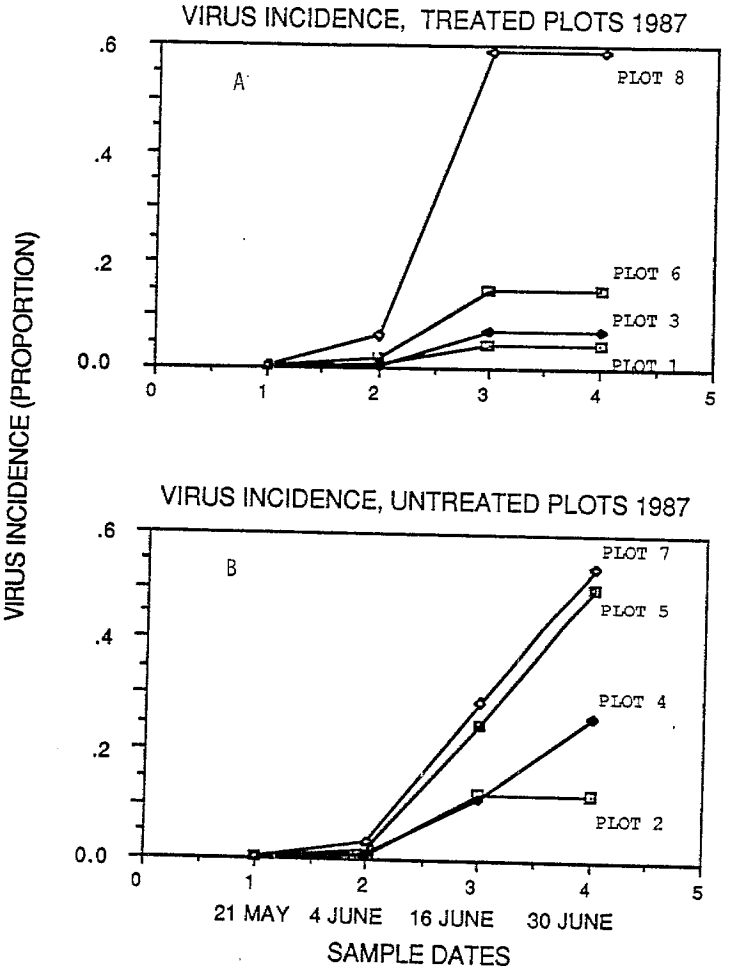

FIGURE 1. Potato virus Y (PVY) incidence (proportion of sampled plants infected with PVY) in aphid-treated plots (A) and untreated plots (B). Plots treated with acephate (Orthene TIS), Carteret County, NC, 1987.

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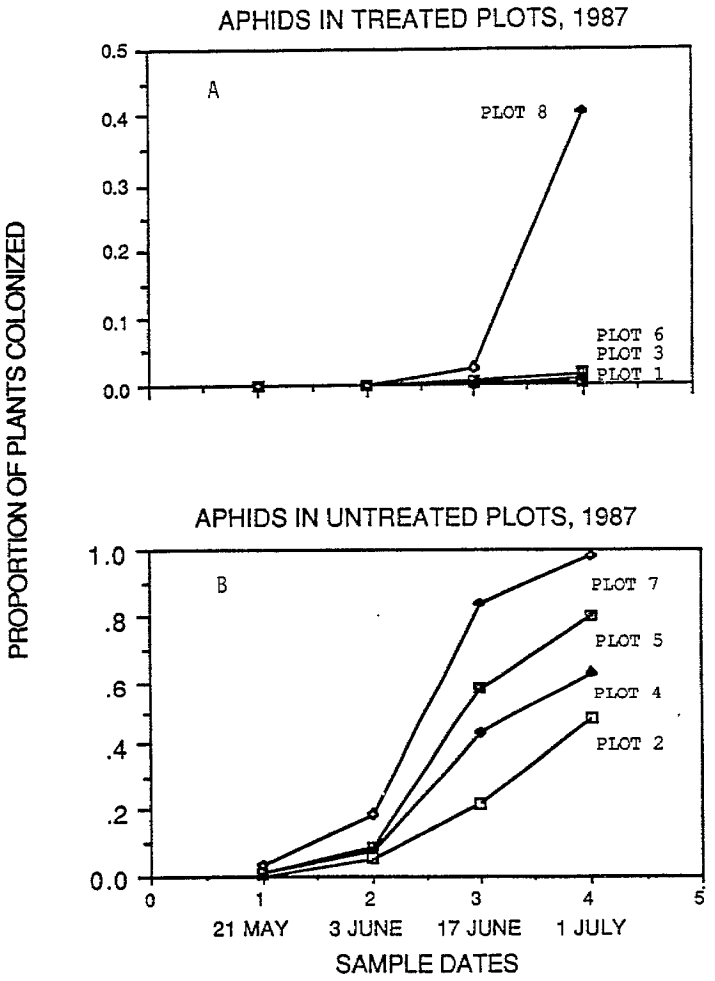

FIGURE 2. Proportion of plants colonized by aphids in treated plots (A) and untreated plots (B). Carteret County, NC, 1987.

FIGURE 3. Effec
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FIGURE 3. Effects of planting date and age of tobacco etch virus (TEV) infection on total number of aphids caught in nine alighting traps per plot. (A) Planting date 1 = 4 May 1987, (B) Planting date 2 = 15 May 1987, (C) Planting date 3 = 26 May 1987. Inoculation status, healthy = uninfected with TEV, INOC 2 = mechanically inoculated with TEV 2 weeks after transplanting, INOC 3 = mechanically inoculated with TEV 3 weeks after transplanting, and INOC 4 = mechanically inoculated with TEV 4 weeks after transplanting. Central Crops Research Station, 1987.

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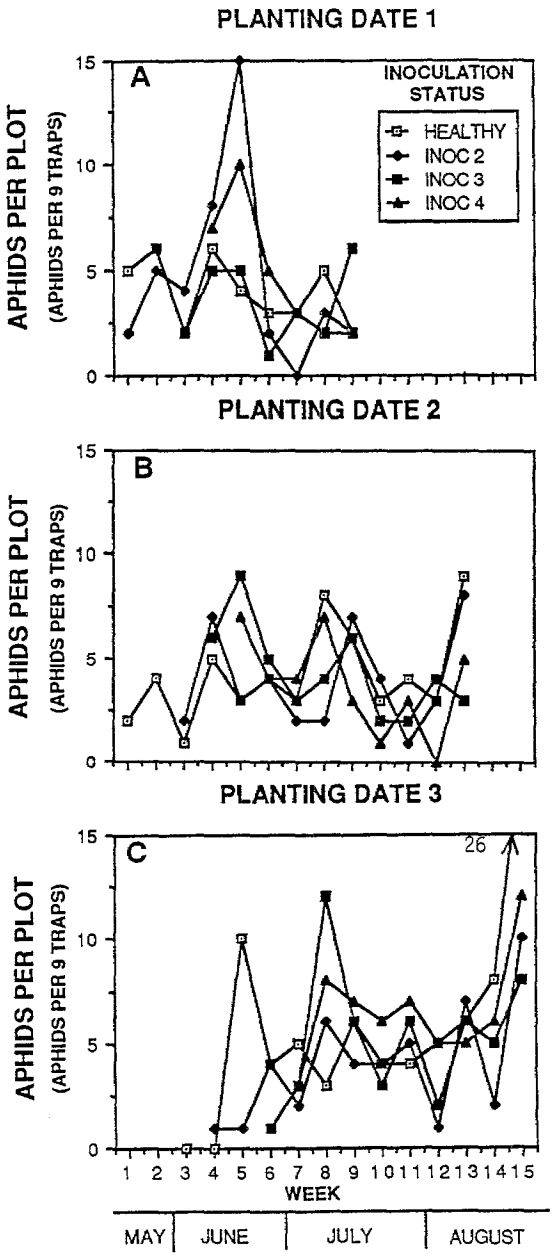

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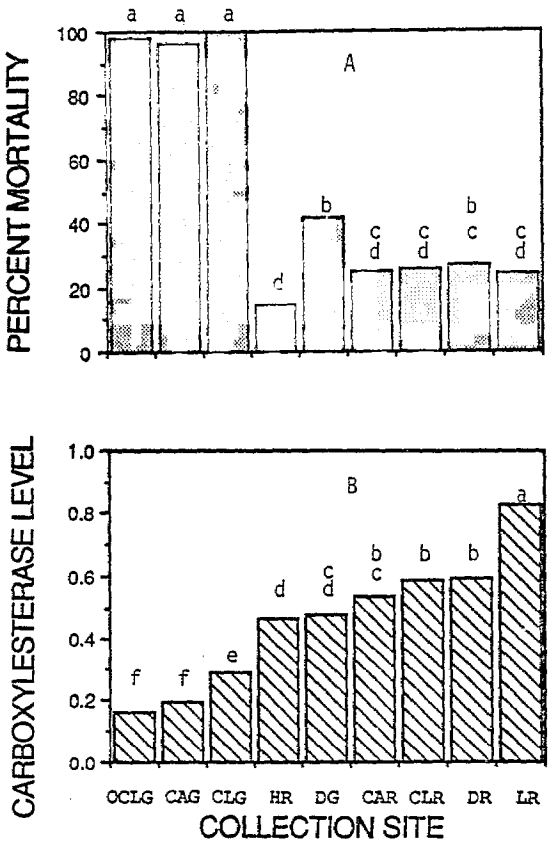

FIGURE 4. Relationship between collection site and percent mortality to monocrotophos (Azodrin) in slide-dip tests (A) and carboxylesterase level (B). Collection sites; CA = Carteret County, CL = Central Crops Research Station, Clayton, H = Halifax County, D = Duplin County and L = Lenoir County. R = red color form , G = green color form. OCLG collected in 1983, all others collected in 1986.

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Figure 1.

Title: NC 00573 Management Strategies for Tobacco Insect Pests

Project Leader: D. Michael Jackson

I. Summary of Research:

A. Host Plant Resistance Studies.

1. The ovipositional responses of tobacco budworm, Heliothis virescens (F.), and tobacco hornworm, Manduca sexta L., moths toward 70 assessions of Nicotiana species were evaluated in choice tests verses NC 2326 flue-cured tobacco in field cages during 1984-87. Egg laying on the various Nicotiana species ranged from nearly zero to over 100% of the numbers deposited on the flue-cured check. Additionally, tobacco budworm oviposition on 32 of the Nicotiana species was determined in no-choice tests in the same field cages in 1986-87. Results were similar between choice and no-choice type experiments. Measures of tobacco budworm ovipositional response were positively correlated to levels of duvane diterpenes and sucrose esters found on the cuticular surfaces of leaves from the Nicotiana species. The distribution of the various acid moieties attached to the different sucrose esters may be important factors in determining the activity of these compounds for stimulating tobacco budworm oviposition.

2. As part of an on-going screening program of tobacco germplasm, 70 tobacco entries were evaluated for insect resistance in replicated field plots at Oxford, N.C. and Tifton, Ga. Good flea beetle data were obtained for the first time in 1987 at Oxford. Natural populations of beneficial and pest insects were also monitored in field plots containing 124 assessions representing 66 Nicotiana species. Entries were planted in 2 replications of 12-plant plots at Oxford, N.C. Green leaf samples were taken from each entry for analyses of leaf surface chemicals. Insect resistance and cuticular chemistry among the TI's and Nicotiana species varied widely.

3. The whole leaf wash, the methanol-water soluble, and the hexane-soluble fractions of Nicotiana kawakamii were extracted (with methylene chloride), fractionated (Fig. 1), formulated, and sprayed onto the leaves of a tobacco budworm-resistant (by ovipositional nonpreference) tobacco entry (I-35 or TI 1112). These plants were bioassayed for tobacco budworm oviposition by choice tests with unsprayed plants in field and greenhouse cages. All of the fractions significantly increased egg laying over the unsprayed plants (Table 1). This work was done cooperatively with Ray F. Severson, Research Chemist, USDA-ARS, Athens, Georgia.

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Figure 1. Fractionation of Methylene Chloride Cuticular Leaf Extract from Nicotiana kawakamii.

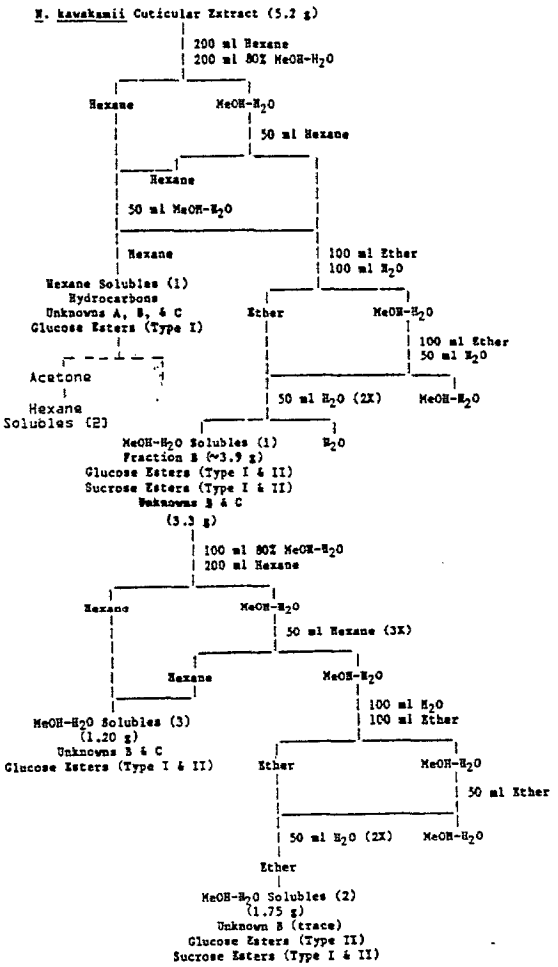

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Table 1. Tobacco budworm moth oviposition on whole tobacco plants or on 71 cm^2 leaf disks in field and greenhouse bioassay studies, Oxford, N.C., 1987.

Exp. No.	Cage Type[a]	No. Reps	Entry A Plant[b]	Entry A Spray[c]	Entry A % of Eggs	Entry B Plant[b]	Entry B Spray[c]	Entry B % of Eggs	t-Test
1	FC	113	NC2326-WP	-	76.4	TI1112-WP	-	23.6	**
2	FC	15	NC2326-WP	-	81.5	I-35 WP	-	18.5	**
3	FC	10	NC2326-WP	-	47.6	N. k.-WP	-	52.0	NS
4	FC	17	I-35 WP	α+β -diols	66.0	I-35 WP	SB	34.0	*
5	FC	16	I-35 WP	α+β -diols	47.9	I-35 WP	α+β -diols	52.1	NS
6	FC	17	I-35 WP	N.k WLW	66.6	I-35 WP	SB	33.4	*
7	FC	10	I-35 WP	N.k WLW	47.8	I-35 WP	α+β -diols	52.2	NS
8	FC	17	I-35 WP	N.k HS (1)	63.0	I-35 WP	SB	37.0	*
9	FC	10	I-35 WP	N.k HS (1)	21.8	I-35 WP	α+β -diols	78.2	**
10	FC	16	I-35 WP	N.k HS (2)	69.2	I-35 WP	SB	30.8	*
11	FC	17	I-35 WP	N.k MWS (1)	66.3	I-35 WP	SB	33.7	*
12	FC	10	I-35 WP	N.k MWS (1)	43.7	I-35 WP	α+β -diols	56.3	NS
13	FC	16	I-35 WP	N.k MWS (2)	69.5	I-35 WP	SB	30.3	*
14	FC	16	I-35 WP	N.k MWS (3)	75.5	I-35 WP	SB	24.8	**
15	LH-F	32	NC2326-L	-	77.8	TI1112-L	-	22.3	**
16	LH-GH	18	NC2326-L	-	63.8	TI1112-L	-	36.2	*
17	LH-GH	18	TI1112-L	α+β -diols	69.6	TI1112-L	SB	30.4	*
18	LH-GH	18	TI1112-L	N.k WLW	64.3	TI1112-L	SB	35.7	*
19	LH-GH	18	TI1112-L	N.k HS (1)	68.4	TI1112-L	SB	31.6	*
20	LH-GH	18	TI1112-L	N.k MWS (1)	77.4	TI1112-L	SB	22.6	**

[a] FC = 2.4x2.4x2.0 m field cage; LH-F = Large Hoop Cage (0.46x0.46x1.31 M) in Field; LH-GH = Large Hoop Cage in Greenhouse .

[b] WP = Whole Plants (2); L = Leaf Disk Only (71 cm^2); N.k. = Nicotiana kawakamii.

[c] α+β -diols = α+β -4,8,13 -duvatriene -1,3 -diols (55 mg/plant); N.k. WLW = Nicotiana kawakamii whole leaf wash (methylene chloride cuticular leaf extract at 70 mg/plant); N.k. HS (1) = N. kawakamii hexane-soluble fraction; N.k. HS (2) = acetone soluble portion of HS (1); N.k. MWS(1) = N. Kawakamii methanol-water soluble fraction; N.k. MWS (2) and N.K. MWS (3) = further fractionations of MWS (1) (see Figure 1).

[d] NS = Not Significant, * = significant at 5% level, ** = significant at 1% level.

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4. Large quantities (up to 14 kg) of green leaves from 15 Nicotiana species and tobacco introductions were dipped in methylene chloride to extract leaf surface components. These are being fractionated and formulated for future cage bioassay study. Much of 1987 was spent developing a technique using smaller "hoop cages". Laboratory tests using a 40 x 40 x 40 cm plexiglass oviposition cage were largely unsuccessful, but both 0.46 x 0.46 x 0.91 M and 0.46 x 0.46 x 1.31 M "hoop cages", constructed of plywood and hardware cloth, gave good results in 1987 field, laboratory, and greenhouse tests (Table 1). Much of our future bioassay work will use the larger "hoop cages".

5. In cooperation with Dr. Richard Gwynn and others, several advanced breeding lines were evaluated for agronomic, chemical, and insect-resistance qualities. From these efforts, a tobacco budworm-resistant breeding line, NCI514, was released by North Carolina State University in 1987. My contribution into this project was to evaluate advanced breeding material in greenhouse and field feeding bioassays with tobacco budworm larvae. During 1986, nine individual F5 selections, which were developed from NC 82 and TI 165 parents, were resistant to feeding by tobacco budworm larvae but not to tobacco budworm oviposition. NCI514, which processes acceptable agronomic and chemical traits, was chosen for release.

6. Alkaloid development was monitored at five leaf positions in four isogenic tobacco lines, which varied in alkaloid levels, and in a flue-cured check, NC 2326. Samples for alkaloid analyses were taken 9 weeks after transplanting. At weeks 10 and 14 after transplanting and at curing, additional samples were taken to determine within-leaf alkaloid distribution for NC 95 and LA 53 (low alkaloid). In general, alkaloids were highest in the leaf tips and leaf edges. Levels declined toward the midrib and toward the base of the leaves. As leaves ripened from the botton of the stalk, alkaloids are translocated from the roots. Final alkaloid levels were highest in the top leaf positions. The survival and development of tobacco budworm larvae closely followed the suspected alkaloid distributions (1986 experiments). Larvae developed at the highest rates in the buds of a particular entry. More larvae survived on the lower leaves of the low alkaloid lines than on the lower leaves of the high alkaloid lines. For any leaf position, there was a negative correlation between budworm survival and the levels of tobacco alkaloids.

kawakamii whole leaf wash (methylene chloride extract; (1) = N. kawakamii hexane-soluble fraction; N.k. HS (2) = acetone soluble portion of the N.k. MWS(1) = N. kawakamii methanol-water soluble fraction; N.k. MWS (2) and N.K. MWS (3) = further fractionations of MWS (1) (see Figure 1).

d_{NS} = Not Significant, * = significant at 5% level, ** = significant at 1% level.

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7. The within-plant distribution of Heliothis virescens eggs laid on potted NC 2326 tobacco plants was measured over the season in field oviposition cages. Over a four week period (Aug. 6 - Sept. 3, 1987), all the tobacco budworm eggs were counted on 136 tobacco plants that ranged from 43 to 72 days after transplanting. For each experiment, four NC 2326 tobacco plants were evenly spaced on the floor of a 2.4 x 2.4 x 2.0 M screen field cage. Ten tobacco budworm female moths, that had been in small mating cages with males for 2 nights, were placed into each cage. The following morning all eggs were counted, and their positions on the plant were recorded. Leaves were divided into apical, central, and basal sections, and these sections were further divided into marginal or medial halves and upper and lower surfaces. Ca. 96% of all the eggs were deposited on leaves while 4% were on the stalks. Of the eggs laid on leaves, 54% were found on the upper leaf surface and 46% on the lower leaf surface. The largest percentage of eggs were laid on the fifth leaf below the bud, but the second leaf below the bud had the most budworm eggs per unit area of leaf (Table 2). The basal portions (46.2%) of leaves received more eggs than the central (33.7%) which received more eggs than the apical section (20.1%) (Table 3). Leaf margins (57.6%) were preferred over medial areas (42.4%). Within-leaf chemical components were sampled, but have not been analyzed to date.

B. Bacillus thuringiensis Studies.

Several formulations of Bacillus thuringiensis var. kurstaki (B.t.k.), fenoxycarb, three new B.t. strains and Thuringiensin (β-exotoxin, a secondary metabolite of certain B.t. strains), were tested for control of tobacco budworm and tobacco hornworm larvae on flue-cured tobacco in field tests. All B.t.k. formulations gave good tobacco budworm control, but granular formulations of B.t.k. were superior over most liquid and wettable power formulations at equivalent rates of active ingredient. Thuringiensin formulations gave fair tobacco budworm control at higher rates, but they were not effective against tobacco hornworms. Fenoxycarb was inactive against both tobacco budworm and tobacco hornworm larvae.

C. Insecticide Evaluations in Tobacco Seed Nurseries.

Several insecticides were tested for control of tobacco budworm larvae in the flue-cured tobacco seed nurseries. The best control was achieved with Pounce, Lannate, Orthene, Galecron, and Dipel 2X when sprayed on the plants before they were bagged for seed production. These data will be published in Insecticide and Acaracide Tests.

Table 2. Tobacco Budworm Oviposition on NC 2326 Tobacco in Screen Field Cages, Oxford, NC, 1987.

Leaf Number from Bud	Number of Eggs On			Percent of Total	Percent of Eggs on Lower Leaf Surface	Average Leaf Area - cm^2 (Both Surfaces)	$Eggs/cm^2$ of Leaf (X 1000)
	Upper Leaf Surface	Lower Leaf Surface	Total Leaf				

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Table 2. Tobacco Budworm Oviposition on NC 2326 Tobacco in Screen Field Cages, Oxford, NC, 1987.

Leaf Number from Bud	Number of Eggs on Upper Leaf Surface	Number of Eggs on Lower Leaf Surface	Number of Eggs on Total Leaf	Percent of Total	Percent of Eggs on Lower Leaf Surface	Average Leaf Area - cm^2 (Both Surfaces)	Eggs/cm^2 of Leaf (X 1000)
Bud	0	2	2	<0.1	100.0	15.2	1.0
1	62	160	222	4.6	72.1	92.0	17.7
2	285	342	627	13.1	54.5	221.1	20.9
3	375	362	737	15.4	49.1	360.3	15.0
4	387	372	759	15.8	49.0	488.2	11.4
5	490	334	824	17.2	40.5	556.6	10.9
6	319	239	558	11.6	42.8	619.3	6.6
7	261	171	432	9.0	39.6	639.3	5.0
8	222	115	337	7.0	34.1	645.7	4.0
9	132	83	215	4.4	38.6	648.1	2.9
10	52	11	63	1.3	—	—	1.1
11	9	11	20	0.4	—	—	0.7
12	0	2	2	<0.1	30.0	754.6	0.1
13	0	0	0	0.0	—	—	0.0
14	0	2	2	<0.1	—	—	0.2
TOTAL	2594	2206	4800	100.00	100.00	459.2	7.0

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Table 3. Within-leaf Position of Tobacco Budworm Eggs on NC 2326 Tobacco, Oxford, NC, 1987.

Leaf Position	Percent of Tobacco Budworm Eggs on Upper Leaf Surface	Lower Leaf Surface	Total Leaf
Apical - Marginal	6.9	5.4	12.3
Apical - Medial	5.1	2.6	7.8
Apical Total	**12.1**	**8.0**	**20.1**
Central - Marginal	10.4	9.0	19.4
Central - Medial	10.1	4.1	14.3
Central Total	**20.5**	**13.1**	**33.7**
Basal - Marginal	9.8	10.0	19.7
Basal - Medial	8.0	7.8	15.8
Basal - Stem & Skirt	3.7	7.0	10.7
Basal Total	**21.4**	**24.8**	**46.2**
TOTAL	54.1	45.9	100.0

D. Insect Monitoring Program.

A tobacco insect pest monitoring program was continued in Granville County, N.C. Adult tobacco budworms, tobacco hornworms, and tomato hornworms were collected weekly from 8 traps each of 3 different types: (1) wire cone traps baited with Virelure, (2) electric grid traps baited with Virelure, and (3) blacklight traps. An insect monitoring program has been in continuous operation since 1962. These data are useful in recognizing patterns of pest or beneficial species fluctuations. The importance of certain pest species have changed over the years, which may be correlated to changes in cultural practices for insecticide-use patterns. Additional wire cone traps baited with Zealure have been monitored for 3 years to determine corn earworm numbers.

In conjunction with our host plant resistance studies, cone-type traps, baited with a commercial preparation of Virelure that attracts male tobacco budworm moths, were monitored at Oxford, NC and Tifton, Georgia for the 6th year. Data are being combined with past and future information on Heliothis captures in order to more accurately predict peak adult populations levels. These predictions will be used to better plan field experiments and for determining optimum planting dates for host plant resistance field screening tests. Similarly, data from blacklight traps at Oxford and Tifton are being used to predict hornworm outbreaks.

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E. Insect Rearing.

A major time- and resource-consuming activity continues to be the maintenance of laboratory colonies of tobacco budworms, tobacco hornworms, tomato hornworms, and Cotesia congregata. These colonies are primarily intended for our own use, but excess insects were sent to several cooperators throughout the United States.

F. Minimum Tillage Experiments.

In a cooperative experimet with NCSU soil entomologist, Gar House, we studied for the third year the levels of soil-inhabitation pest and beneficial species in tobacco plots with several tillage schemes. Beneficial predators are higher in no-till and mulched plots. These insects will feed on tobacco budworm pupae.

II. Graduate Students: None.

III. Postdoctoral Fellows: None.

IV. Publications:

Jackson, D.M., A.W. Johnson, R.F. Severson, J.F. Chaplin, and M.G. Stephenson. 1987. Levels of cuticular components and insect damage on green leaves of normal, late-planted, and ratoon tobacco. Tobacco Sci. 31: 94-98.

Schneider, J.C., A.M. Hammond, D.M. Jackson, E.R. Mitchell, and R.T. Roush (Editors). 1987. In Theory and Tactics of Heliothis Population Management: II. Insecticidal and Insect Growth Regulator Control. Southern Coop. Ser. Bull. 329, 54 pp.

Jackson, D.M. 1987. Control of tobacco insect pests with Bacillus thuringiensis var. kurstaki and Thuringiensin formulations, 1986. Insect. Acar. Tests 12: 292-294.

V. Manuscripts Accepted for Publication:

Jackson, D.M. 1988. Control of tobacco insect pests with various formulations of Bacillus thuringiensis, thuringiensin, and fenoxycarb, 1987. Insect. Acar. Tests 13: (In Press).

Jackson, D.M. and G.R. Gwynn. 1988. Tobacco budworm control in tobacco seed nurseries, 1987. Insect. Acar. Tests 13: (In Press).

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Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

VI. Manuscripts in Review:

Jackson, D.M., R.F. Severson, A.W. Johnson, G.R. Gwynn, J.F. Chaplin, V.A. Sisson, and G.A. Herzog. 198_. Host plant resistance in tobacco to Heliothis species. In Theory and Tactics of Heliothis Population Management: III. Emerging Control Tactics and Techniques for Heliothis. Southern Coop. Ser. Bull. (In Review).

Jackson, D.M. and J.J. Lam, Jr. 198_. Toxicity of transplant water and soil-applied pesticides of flue-cured tobacco on Jalysus wickhami Van Duzee (Hemiptera: Berytidae). J. Econ. Entomol. (In Review).

VIII. Papers Presented at Professional Meetings:

Jackson, D.M. 1987. Evaluating tobacco for insect resistance. Invited paper presented at the International Germplasm Workshop, Aug. 2-22, 1987, North Carolina State University.

Jackson, D.M. 1987. Factors affecting Manduca species composition on flue-cured tobacco. Paper No. 1364, presented at the 1987 National Meeting of the Entomological Society of America, Nov. 29 - Dec. 3, 1987, Boston, Massachusetts.

Jackson, D.M. 1988. Advances in Host Plant Resistance in Tobacco. Talk presented at 1988 Tobacco Workers Seminar, Feb. 24-25, 1988, Savannah, Georgia.

Jackson, D.M. and R.F. Severson. 1987. Alkaloid development and tobacco budworm survival on isogenic tobacco lines. Paper presented at the 41st Tobacco Chemists' Research Conference, Oct. 4-7, 1987, Greensboro, North Carolina, Abstract No. 62.

Botkin, J.H., D. Jones, D. Scarborough, R. Severson, and M. Jackson. 1987. Toxicological studies on a novel group of nicotine alkaloids. Kentucky Acad. Sci. Meet., Bowling Green, Kentucky.

Scarborough, D., D. Jones, R. Severson, and M. Jackson. 1987. Toxicological studies on N-acylnornicotines from wild Nicotiana spp. paper No. 349 presented at the 1987 National Meeting of the Entomological Society of America, Nov. 29 - Dec. 3, 1987, Boston, Massachusetts.

Severson, R.F., D.M. Jackson, V.A. Sisson, and M.G. Stephenson. 1988. Tobacco budworm ovipositional

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stimulants from the cuticulae of N. kawakamii. Paper presented at the 62nd Annual Meeting of the Southeastern Branch of the Entomological Society of America, Jan. 25-28, 1988, Raleigh, North Carolina.

Snook, M.E., O.T. Chortyk, R.F. Arrendale, V.A. Sisson, and D.M. Jackson. 1987. Interesting polyphenol constituents in the flowers of the Nicotiana species. Paper presented at the 41st Tobacco Chemists Research Conference, Oct. 4-7, 1987, Greensboro, North Carolina, Abstract No. 41.

VIII. Graduate Student Theses Completed During Reporting Period: None.

IX. Acknowledgements:

I wish to thank Jimmy Cheatham, Jimmy Hobgood, and Kaye G. Plair for their excellent technical and clerical assistance.

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Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

Title: Influence of Crop Rotation and Tillage Practices on the Level of Biological Control of Soil Insect Pests

Project Leaders: G. J. House, D. M. Jackson, and D. P. Schmitt

I. Summary of Research:

Soil insect biological control activity was investigated in four tobacco cropping systems: (1) tobacco, wheat, corn, conventionally tilled, (2) tobacco, wheat, corn, no-tilled, (3) corn, wheat, tobacco, conventionally tilled, and (4) corn, wheat, tobacco, no-tilled. Pitfall trapping indicated that predatory arthropod activity was significantly higher ($p < 0.05$) under no-tillage than conventional tillage tobacco, but that the number of herbivorous or crop feeding insects, including click (*Conoderus* spp.) and leaf beetles (Chrysomelidae), was similiar in all treatments (Fig. 1).

More than 50% of the predatory arthropods collected in pitfall traps were carabid or ground beetles (Carabidae: Colepotera) (Fig. 2). Two burrowing, omnivorous ground beetle species, *Harpalus pensylvanicus* and *H. caliginosus*, were particularly abundant in both tobacco and corn no-tillage systems. Several non-burrowing carabid species also commonly occurred, especially the following: *Calosoma externum*, *Megacephala virginica*, *Chlaenius tomentosus*, and *Cratacanthus dubius*.

The ground beetle species listed above were evaluated in laboratory tests for their potential as predators of the soil-inhabiting life stage of the tobacco budworm, *Heliothis virescens*, i. e., the pupal stage. Although all ground beetle species in the study fed on *Heliothis virescens* pupae, the two soil burrowing species, *Harpalus pensylvanicus* and *H. caliginosus*, probably have the greatest potential as naturally occurring biological control agents of tobacco budworm pupae, especially in no-tillage systems. We suspect this because *Harpalus pensylvanicus* and *H. caliginosus* occur in higher number than all other ground beetles combined and also because these two species burrow extensively in the soil, and thus have the ability to seek and destroy buried *Heliothis virescens* pupae more effectively than other ground beetle species. Results from a previous study in 1986 support this contention (House and Jackson, unpublished data).

IX. Acknowledgements:

We wish to thank Charles Warrick, James Cheetham, Michael Bush and Robert Williams for their technical assistance. This research was funded by the North Carolina Tobacco Foundation, Inc.

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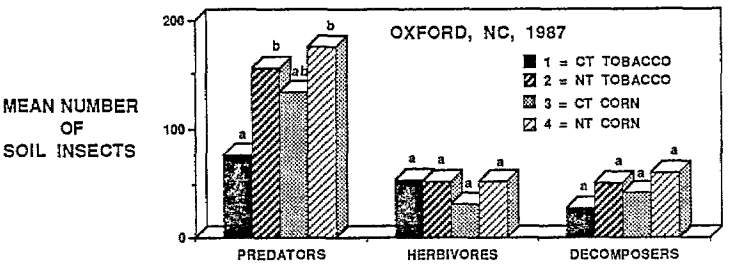

Fig. 1. Mean number of soil insects and other arthropods collected in pitfall traps from conventional and no-tillage tobacco and corn systems during June, July, and August, 1987 at Oxford, NC. Insects are divided into the three major trophic or ecological groups: predators, herbivores, and decomposers. Different letters above a treatment column indicate significant difference at the 0.05 level.

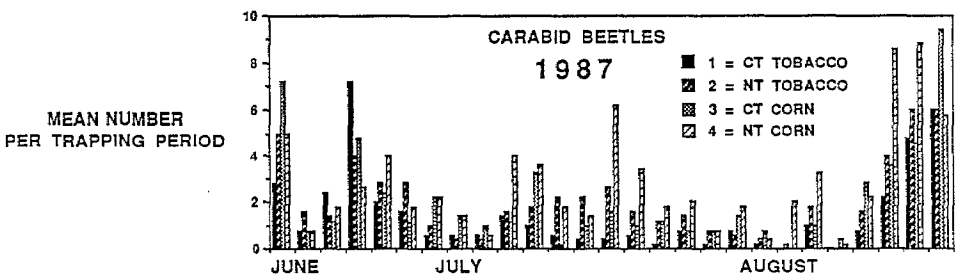

Fig. 2. Mean number of carabid or ground beetles collected in pitfall traps from conventional and no-tillage tobacco and corn systems at Oxford, NC.

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Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

Title: Biology and Control of Insects That Damage Stored Tobacco

Project Leader: Dennis W. Keever

I. Summary of Research:

This project has the following objectives:

A. To develop biological, chemical, and physical control methods and programs for the cigarette beetle in stored tobacco.

B. To investigate the biology and ecology of stored-tobacco insect species.

C. To investigate how biotic and abiotic elements in tobacco storages affect the trapping of the cigarette beetle.

A. Biological Control of the Cigarette Beetle

Abbott Laboratories produces an experimental formulation of thuringiensin that is designated as ABG-6206. In our previous studies ABG-6206 proved very efficacious against the cigarette beetle, Lasioderma sericorne. In this study, ground tobacco was first treated with ABG-6206 at either 0, 15, 30, 45, 60, or 75 ppm. Then either 1st-, 2nd-, 3rd, or 4th-instar larvae of the cigarette beetle were placed on the treated tobacco and allowed to develop into adults. Objectives were to determine effective dose rates and the susceptibility of different larval instars.

Susceptibility to ABG-6206 decreased with increasing larval age (Table 1). When first exposed as 1st-instars, all larvae were killed at 75 ppm. The 3rd and 4th instars differed little in susceptibility. The 45 ppm rate gave almost as much suppression of the 1st instar as did the 75 ppm rate. As in earlier studies, ABG-6206 slowed the rate of cigarette beetle development. Regardless of the instar when first exposed to ABG-6206, development to adulthood took ca. twice as long on the 75 ppm diet as on the control (0 ppm).

Table 1. Percentage cigarette beetles to emerge as adults

ABG-6206 (ppm)	Larval instar when first exposed			
	1st	2nd	3rd	4th
0	96	97	96	92
15	50	39	91	60
30	22	34	73	55
45	3	14	36	30
60	1	23	22	26
75	0	8	34	14

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B. Biological Control of the Tobacco Moth

Thuringiensin (ABG-6206) was tested at 60 ppm as a population suppressant of the tobacco moth, Ephestia elutella; the lesser grain borer, Rhyzopertha dominica; and the maize weevil, Sitophilus zeamais. First-generation progeny production was reduced as follows: tobacco moth on treated tobacco (100% reduction), lesser grain borer on treated whole wheat kernels (99% reduction), and maize weevil on treated whole wheat kernels (82% reduction).

After no tobacco moths developed on the treated tobacco, 400 more tobacco moth eggs were placed on the same treated tobacco three months after application of the ABG-6206. Again, no moths developed indicating effective residual activity of at least three months.

C. Physical Control of the Cigarette Beetle

Irradiation with X-rays was tested as a means of disinfesting cigarettes of the cigarette beetle. One cigarette was removed from each pack within a carton of cigarettes. Eggs, larvae, pupae, and adults of the cigarette beetle were then placed into gelatin capsules and put into the void created by the missing cigarette. Packs were returned to the carton and the cartons were X-irradiated at 5, 10, and 20 krads. Two tests were conducted, each with different developmental stages being used. Survivors of the irradiation were set up on rearing medium and allowed to reproduce in order to check for sterility.

Preliminary tests indicated that the gelatin capsules did not affect mortality of the insects or their susceptibility to irradiation. Only the egg stage experienced significant mortality (Table 2). Adults and larvae were not affected at all. Adults irradiated at 5, 10, and 20 krads produced only 30, 8, and 16% as many progeny, respectively, as did the controls. Reduced progeny production was not observed for any of the other irradiated developmental stages.

Table 2. % Cigarette Beetle Mortality From X-Irradiation

CB stage	Test	Dosage (krads) 0	5	10	20
Egg	1st	2	90	96	100
	2nd	8	38	100	100
Larva (2nd)	2nd	0	0	0	0
Larva (4th)	1st	0	0	0	0
	2nd	0	0	0	0
Pupa	1st	6	12	23	19
	2nd	13	13	10	15
Adult	1st	0	0	0	0

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Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

II. Graduate Students: none

III. Postdoctoral Fellows: none

IV. Publications:

Keever, D.W., B.R. Wiseman, and N.W. Widstrom. 1987. Effects of harvesting and drying of maize weevil populations in field-infested corn. Proc. 4th Intern. Conf. Stored-Product Protection: 447-453. Tel Aviv, Israel.

Keever, D.W. 1987. Pathogenic effects of thuringiensin on immature Lasioderma serricorne (F.) in the laboratory. Proc. 32nd Tobacco Workers Conf. (Abstract)

V. Manuscripts Accepted for Publication: None

VI. Manuscripts in Review:

Keever, D.W. Freezing of tobacco samples for the disinfestation of the cigarette beetle, Lasioderma serricorne (F.). To be submitted to Tob. Sci.

VII. Papers presented at Professional Meetings:

Keever, D.W. Population effects of thuringiensin on Lasioderma serricorne (F.). Annual Meeting of Entomological Society of America, Nov. 29 - Dec. 3, 1987. Boston.

Keever, D.W. Research on stored-tobacco insects. Invited paper presented at Univ. of Kentucky Fumigation Short Course, Feb. 15-16, 1988, Lexington.

IX. Acknowledgements:

Jim Overby made major contributions to this work through his highly skilled technical assistance. Also, the X-irradiation was conducted by Citrex Technologies of Gainesville, Florida.

Title: NC03699

Project Leader:

1. Summary of
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Source: https://www.industrydocuments.ucsf.edu/docs/ysyk0000

Title: NC03699 Pesticide Residues in Tobacco, Tobacco Products, and Main-Stream Smoke

Project Leader: T. J. Sheets

1. Summary of Research:

Residues of Chlorinated Hydrocarbon Insecticides in 1986 Tobacco Products. The procedure for sampling and analyzing the 1986 product samples was changed from that used in the past to permit an estimate of the variation due to sampling. Product samples were collected four times and the samples processed separately.

Averages over all samplings and brands showed the total TDE plus total DDT in cigarettes, cigars, pipe tobacco, chewing tobacco, and snuff to be <0.12, 1.18, 0.42, 0.24, and <0.12 ppm, respectively. Thirty-seven of eighty cigarette samples contained detectable amounts of DDT, but the low readings for TDE caused the averages for TDE + DDT to drop below the lowest detectable limit in most samples. Several individual samples of cigars and pipe tobacco contained total TDE + DDT residues in excess of 2 ppm. For some product samples, the residue was relatively constant over four sampling times; there was wide variation for others.

The number of positive values for TDE + DDT in cigarettes was insufficient for a valid statistical analysis to determine the variation associated with sampling time and product. However, total DDT residues (TDE + DDT) in all 1986 cigar samples exceeded the low detectable limit, and we were able to estimate the variation associated with sampling time and products. There was more variation among cigar means than among sampling dates. Statistical analysis showed a highly significant F value for cigar brands but not for sampling times.

Levels of toxaphene were below the lowest detectable limit (0.3 ppm) in all product samples except one brand of chewing tobacco in the fourth sampling, which had a concentration of 1.14 ppm. Dieldrin was barely detected in a few samples of pipe tobacco, chewing tobacco, and snuff. Low levels of endrin were found in three samples of cigars from the first sampling.

Positive values for chlorinated hydrocarbons were not confirmed, and extraneous peaks sometimes exhibit the same retention time on the gas chromatograph as the insecticides.

MH Residues in 1986 Flue-Cured and Burley Tobacco. The average residue of MH in flue-cured tobacco was higher in 1986 than in 1985 and about equal to 1984. In 1986, MH levels in composite samples from auction markets ranged from 20 to 214 ppm with an average of 102 ppm, compared to an average of 101 ppm for the 1984 crop. Average residues for 1986 were 160 ppm for the Georgia-Florida Belt, 116 ppm for the Border Belt, 104 ppm for the Eastern Belt, 92 ppm for the Middle Belt, and 39 ppm for the Old Belt.

Residues in 24 composite samples of 1986 burley ranged from 25 to 102 ppm. The average for all of the burley samples in 1986 (90 ppm) was

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greater than that for 1985 (52 ppm) and 1984 (49 ppm) but less than the value for 1983 (102 ppm).

MH Residues in 1986 Tobacco Products. When averaged over all samplings and brands, MH residues were 45, <10, 21, <10, and 19 ppm, respectively, for cigarettes, cigars, pipe tobacco, chewing tobacco, and snuff. When compared to 1985 results, residues declined in cigarettes, pipe tobacco, and chewing tobacco. The average for snuff appeared to be down slightly from 1985, and that for cigars remained near the lowest detectable limit of 10 ppm. When averaged over all cigarette brands, MH residues were 45, 52, 45, and 40 ppm for the four sampling times.

Statistical analysis of MH residues in 1986 cigarettes showed a highly significant F value for sampling times but not for cigarettes. Therefore, multiple samplings would provide a better estimate of the average MH residue in individual cigarette products than a single sampling. The sampling method was not designed to compare the means of the four sampling times with values for composite samples, and we believe our method of compositing samples over time provides a good estimate of the over-all MH residue in U.S. cigarettes.

Fenamiphos Residues in Cured Tobacco After Pretransplant Application. Field tests were conducted at two locations in 1986 and 1987 to determine residues of the nematicide fenamiphos in flue-cured tobacco after pretransplant application. Samples collected both years were cured, ground, and stored at -18C. A method for total residue (fenamiphos and its sulfoxide and sulfone) is currently being evaluated for use in this study.

Flumetralin Residues in 1986 Flue-Cured and Burley Tobacco. Residues of flumetralin in composite samples of flue-cured tobacco ranged from <0.10 to 1.15 ppm and averaged 0.17 ppm over all stalk positions and belts. There did not appear to be a relationship to stalk position. Avereage residues were 0.19, 0.16, <0.10, <0.10, and 0.33 for the Georgia-Florida, the Border, the Eastern, the Middle, and the Old belt, respectively. The highest value for an individual composite sample represented bottom stalk tobacco from the Old belt.

The flumetralin residues in composite burley samples ranged from <0.10 to 4.06 ppm and averaged 0.92 ppm over stalk positions and Marketing Areas. Values for most composite samples were above the lowest detectable limit of 0.10 ppm. Average residues were 0.20, 0.30, 0.98, and 2.21 ppm, respectively, for Marketing Areas A, B, C, and D. The 0.92 over-all average for burley was more than five times the average for all flue-cured samples.

Effects of Soil-Applied Picloram and Dicamba on Flue-Cured Tobacco. Symptoms of picloram were observed on tobacco at 2 of 3 locations in 1987 from applications of 1.6 g/ha in 1986. Dicamba was far less persistent than picloram. Only a very few plants at 1 of 3 locations exhibited symptoms in 1987 from dicamba applied in 1986 at 410 g/ha. Yield and grade index were not affected in 1987 from picloram and dicamba applied the year before.

II. Graduate Stude
Powell, Kevin
Thesis Titl

III. Postdoctoral

IV. Publications:
House, G. J.,
Herbicide
decomposi
Biol. Fer

Atwood, S. T.
Stability
in aqueo

Seltmann, H.
hydrazide
Tob. Sci.

Leidy, R. B.,
residues
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Sheets, T. J.
Tobacco I
Extension

V. Manuscripts in
Sheets, T. J.,
Residues
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Leidy, R. B.,
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VI. Graduate Stude
Metabolic Fate
Powell, T

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This work was
Tobacco Foundation,
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Corporation, Philip
the Tobacco Advisory

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II. Graduate Students:

Powell, Kevin E., MS, Toxicology
Thesis Title: Metabolic Fate of ^{14}C-Maleic Hydrazide in Tobacco Plants

III. Postdoctoral Fellows: None

IV. Publications:

House, G. J., A. D. Worsham, T. J. Sheets, and R. E. Stinner. 1987. Herbicide effects on soil arthropod dynamics and wheat straw decomposition in a North Carolina no-tillage agroecosystem. Biol. Fertil. Soils. 4:109-114.

Atwood, S. T., T. J. Sheets, T. B. Sutton, and R. B. Leidy. 1987. Stability of selected pesticide formulations and combinations in aqueous media. J. Agric. Food Chem. 35:169-172.

Seltmann, H. and T. J. Sheets. 1987. Sucker control and maleic hydrazide residues after simulated rain and MH reapplications. Tob. Sci. 31:82-87.

Leidy, R. B., T. J. Sheets, and C. G. Wright. 1987. DDVP residues in air following application to a tobacco-storage warehouse. Environ. Monit. Assess. 9:263-268.

Sheets, T. J. 1988. Pesticide residues. Pages 78-81 In Burley Tobacco Information, The North Carolina Agricultural Extension Service, Raleigh, NC.

V. Manuscripts in Review:

Sheets, T. J., R. B. Leidy, C. E. Main, and P. B. Shoemaker. Residues of EBDC and ETU from mancozeb and maneb applied to flue-cured tobacco.

Leidy, R. B., P. B. Shoemaker, T. J. Sheets, and C. E. Main. Residues of EBDC and ETU on burley tobacco.

Sheets, T. J. and L. A. Nelson. Variation of MH residues on flue-cured tobacco.

VI. Graduate Student Thesis Completed During Reporting Period:

Metabolic Fate of ^{14}C-Maleic Hydrazide in Tobacco Plants. Kevin E. Powell, Toxicology Program.

VII. Acknowledgements:

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L. N. Newman
Ernest Price
H. Seltmann
P. B. Shoemaker
Fred Smith
Glen Tart
W. H. Ward
W. W. Weeks
A. D. Worsham

Title: NC 0396

Project Leaders

I. Summary of

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